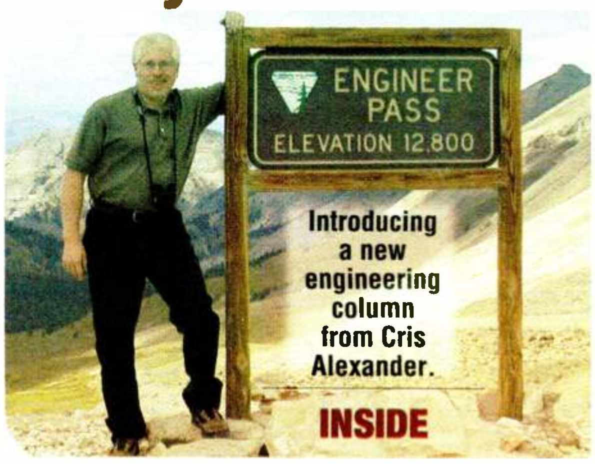
A Day in the Life



Radio World
ENGINEERING EXTRA

August 23, 2006

Six Areas of Focus for Engineering Managers

Communication, Preventive Maintenance Program Are Among Keys to Successful Engineering Department

by Rolin Lintag

The author is chief RF engineer for Victory Television Network in Little Rock, Ark.

Your promotion to the level of supervisor or beyond may have opened a new concept to you as far as your career is concerned. Engineers, especially, can find it difficult to go through this kind of transition.

You'll be working with people more than machines. You'll be dealing with intangibles like attitudes, morale and respect more than calculators and electronic parts. You'll be accountable for the work of others as well as your own. You'll have to relate more with people who don't understand 99 percent of your lingo. And you'll have to stand in front of

SEE FOCUS, PAGE 10

CONSULTANT INTERVIEW

V-Soft Strives for Accurate Modeling

Doug Vernier Discusses Coverage Predictions, Says Accurate Databases Yield Realistic Reception Maps

by Steve Callahan

How many times have you seen a radio station coverage map with a contour circle the same diameter as a CD?

Today's manager has to know the station's realistic and accurate service area. Doug Vernier, founder and president of V-Soft Communications, has been a pioneer in computer modeling of radio station signal contours and the factors that can influence them. He was a member of the NPR board of directors for six years and is now a technical consultant to the Corporation for Public Broadcasting, helping evaluate the technical aspects of the distribution of its HD Conversion Fund.

Vernier also is a collector of classic radios from the golden age and has been a ham operator since age 12. He spoke with RWEE recently about his start in broadcasting and the launch of V-Soft Communications.

Where did you grow up and go to school?

I was born in Detroit and grew up in the area. I graduated from Dearborn High School and I received both bachelors' and masters' degrees in telecommunications from the University of Michigan in Ann Arbor.

Doug Vernier

How did you get interested in broadcasting?

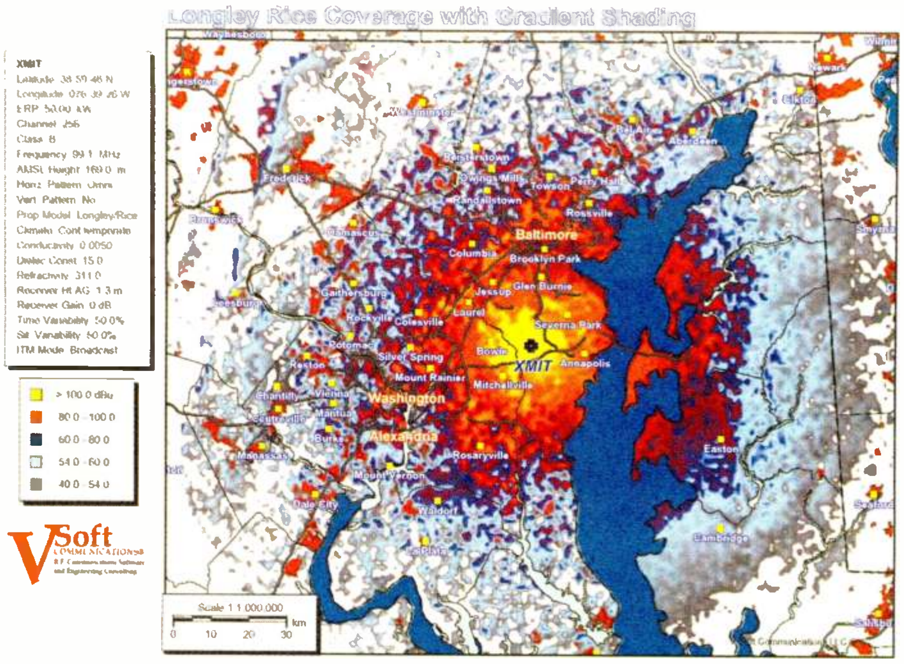
I think my first interest in radio came when I was about five years old. We were visiting my aunt and uncle, who had a gorgeous Zenith radio as the centerpiece in their living room. It had one of those large lighted dials. They let me play with it and I was hooked.

What was your first experience in radio?

[In] college, I worked for WCBN, which at the time was the student carrier current station at University of Michigan, with studios in the three main men's dorms. My first job was a fill-in DJ. I can remember announcing parades and doing live events. Eventually, I bagged one of those "prestigious" rock-and-roll shows that were the "in" thing with the coeds.

It was great fun and I always thought I gained as much from that work as from my real credit courses.

SEE VERNIER, PAGE 6



Longley-Rice Map

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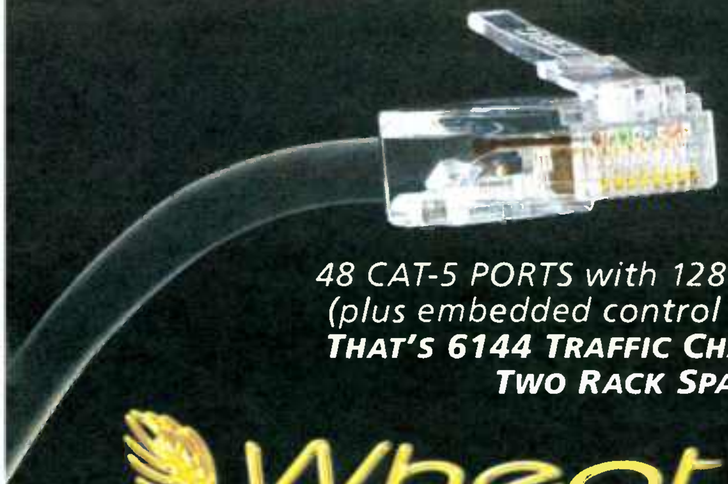

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FROM THE TECH EDITOR

by Michael LeClair

The Final Step in HD Setup Takes Using Your Ears

Diversity Delay Adjustment Is Also a Lesson in Psycho-Acoustics

A topic making the rounds in engineering discussions is the setup of the analog diversity delay on HD Radio stations. This month I thought I would share my own recent experiences in this area.

I was working late at the transmitter site the other night, completing the wiring and setup of an FM HD signal. Although this station was using a backup audio path while I worked, it made sense for me to work during evening hours in case I inadvertently pulled the wrong wire. It is always hard to explain an "oops" that happens during drive time.

One of the last tasks after getting the digital processor adjusted to sound the way I wanted was to set the delay on the analog audio so that it matched the digital. This last step is of vital importance to consumer acceptance of HD Radios and should be done with care. If owners of a BMW 5 Series get confused by the operation of their new car's radio and ask to have it removed because it keeps cutting back and forth in time, HD Radios will take a long while indeed to make it into the dashboard of the majority of new cars.

I'm lucky in that we had just installed one of the new HD monitors from DaySequerra. The monitor can be placed into split-mode operation with the push of a button and has a high-quality headphone amplifier that can be turned up loud enough to overcome the noise of multiple transmitters in operation. This was a big improvement over trying to use a pair of speakers or trying to get it right by listening to the transition as an HD Radio acquires digital and blends from analog over and over again.

Using your ears to measure the time difference between a pair of audio signals is an interesting exercise. It takes a bit of concentration to hear which signal arrives first when they are only separated by about 100 milliseconds. With a little practice I got the hang of it and began to adjust the delay in the right direction.

TAKING PRECEDENCE

What I heard as I moved the delay closer to an exact match was an interesting illustration of something called the "Haas Effect."

Also known as the Precedence Effect, this refers to the brain's inability to differentiate sounds that arrive at the ear closer than about 20–30 milliseconds. If I am walking through the woods and hear a sound, like the snapping of a twig, and I hear another similar sound a few milliseconds later, I will only hear the first twig snap; the second sound will be masked by the first. Many people with very good hearing can hear differences as small as around 10 milliseconds, but on average the ears aren't able to detect delays that small. This limitation on the brain's ability to process sounds is an important aspect of making the blend in HD Radio receivers from analog to digital audibly seamless. It is also employed to advantage in audio codecs and public address systems on a daily basis.

I was able to get the two signals matched to around 12 milliseconds or so. As the two signals got closer together they suddenly start to blend with an odd hollow sound. This happens when the two signals get to within about 25–35 milliseconds of each other in timing. The hollowness is caused by comb filtering that occurs as different frequency components of the audio arrive out of phase from one ear to the other.

As the timing gets even closer, the two signals start to blend into one sound. At this point, with very careful listening, you can make the adjustment even more precise by trying to move the sound into the center of your head. If you hear the sound louder on one side than the other, that means the louder side is arriving first and taking "precedence" over the later arriving sound. However, at a noisy transmitter site this subtlety can be hard to detect and it turns out that it needs to be even closer than this. On another HD Radio receiver in a quiet location you can still hear the blending of analog into digital as a slightly out-of-phase mix for a brief second. It takes training to hear this but it is hard to not hear it once you have noticed it.

What I heard as I moved the delay closer to an exact match was an interesting illustration of something called the 'Haas Effect.'

In the end we used our digital mixing software at the studio to record and measure the time difference between the analog and digital signals. Using the measured difference you can manually enter the correct timing into the digital exciter or other delay box used to adjust the analog signal. After correcting to within 100 microseconds the blend was inaudible to me on our HD monitors. This seems to be the level of accuracy required to get the analog to digital blend to be completely inaudible.

I know that many engineers are out there now facing the need to get these adjustments right. I hear many complaints about the lack of synchronization between the analog and digital signals on HD stations. This is what we had to do in order to get it right.

ENGINEERING EXTRA EXPANDS

This issue marks the end of the second full year of Engineering Extra. Thanks to you, this has been a successful launch of a new publication to serve the radio engineering community.

You may have noticed that the paper in your hands is a bit heftier. We're growing; and this allows us to bring even more "deep tech" information, in-depth interviews and new favorite columnists.

I want to welcome Cris Alexander, a writer and engineer whom I greatly respect, to our regular rotation of columnists. Cris, one of our industry's most admired technical leaders, will be contributing a regular column on the day-to-day activities of radio engineers, with lots of great stories of both usual and unusual situations. He will share his experience and great ideas on how to solve technical problems that occur in radio stations every day, or perhaps only once in a lifetime. I'm excited to have Cris aboard and think you will find his column a "must read" in every issue.

This month's interview is with Doug Vernier, the man behind the software used by numerous engineering consultants. Doug shared with us a detailed peek into the world of signal allocation and coverage prediction. I learned much from his candid answers about the mathematics and models behind the contour maps while editing this article. I think you will find it enlightening.

For technical papers, we've got another installment of Buc Fitch's series on HVAC systems; Alan Rauchwerger explains amplifier damping factors; and we delve into audio-over-IP with APT. Plus, Guy Wire looks at the recent droop in the fortunes of satellite radio while Barry Blesser examines the factors that will drive the success of HD Radio.

Thanks for making Engineering Extra a success. Please send your comments, questions or even congratulations to me at *rwee@imaspub.com*. We love to hear from you. ■

IN THIS ISSUE

Crossed-Field Antenna Article Lacked Principle

The analysis that [Valentino] Trainotti produces ("Crossed-Field Antenna Performance," April 5) is based on a guess that he nowhere substantiates. He actually says that the radiation produced will be the addition of two short monopole antenna radiations.

Nowhere does he attempt to drive the separate capacitive plates with voltages that are 90 degrees out of phase. In short, the author is ignoring the concept we are working with. There is no mention of Maxwell's Fourth Equation and the novel use we have made of the ability of a capacitor to create a circular magnetic field around itself, nor is there any mention of the necessity for the two source phases to have a phase adjusting component to eliminate the inherent sine to cosine wave caused by the d/dt term in the Maxwell Fourth Equation.

The long analysis he produces falls flat on its face since he doesn't attempt to incorporate the working principal of the Crossed-Field Effect. E X H is nowhere mentioned.

Readers should remember that a crossed-field antenna is as different from a classical antenna as the Hovercraft is different from a conventional ship.

Maurice Hately
Fellow of the Institution of Electrical Engineers
Hately Antenna Technology
Wells, Somerset, England

A Bargain, But Not Free

I noticed a small error as I was reading Guy Wire's column ("NAB2006 Abuzz Over IP, HD Rollout," June 14).

In the section entitled "Axia On The Move," Guy says, "Axia has written a software driver, available for free, that lets Windows-enabled devices play any audio routed over IP."

We do indeed offer an IP-Audio driver that allows broadcasters to do away with sound cards and send any PC audio directly to Axia networks. Although the driver is reasonably priced, it is not free. I thought I'd at least bring it to your attention.

A single-stream stereo version suitable for laptop producers is available from Axia resellers, and multistream versions that support up to 16 stereo inputs and outputs are available from our delivery system partners. Visit *www.axiaaudio.com/partners/*.

Clark Novak
Marketing Team Leader
Axia Audio
Cleveland

Nighttime Transmission

Michael LeClair's anecdotal report ("Sound Quality, Coverage: Worth the Loss of Reception?," April 5) fails to address or discuss the very real issue of nighttime transmission.

We will be faced with an AM band that is less useful than it is today, as Ibiquity will be unable to change the laws of physics.

With thousands of FM stations, and hundreds of satellite channels, what will be the role of this band? Certainly not to provide music, unless we convince millions of listeners to change preferences as they drive home at night. And talk shows, at their best, will sound just as bad as they do now, after traveling through uplinks and downlinks and several digital compression schemes.

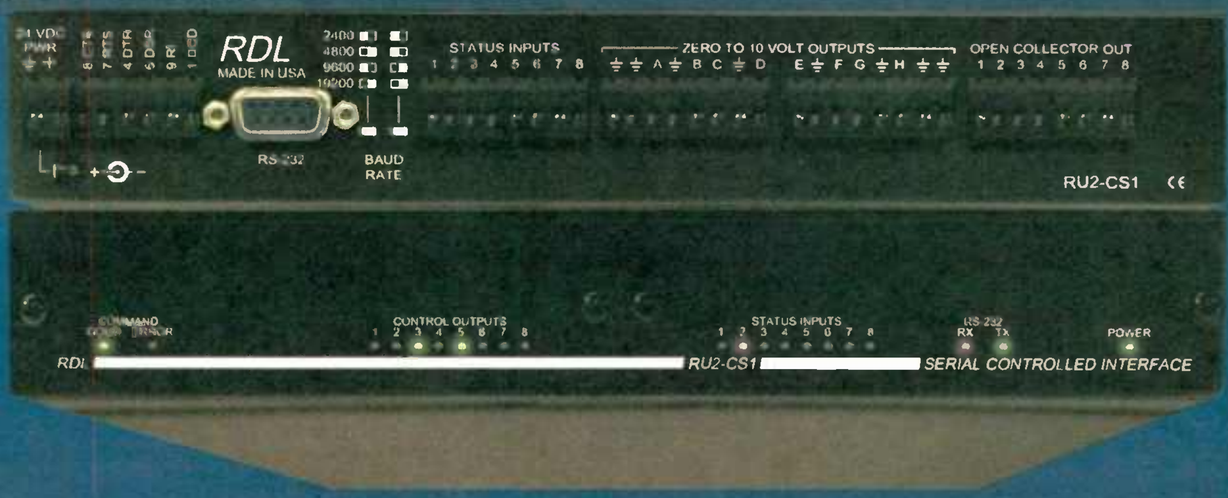
AM IBOC, I am afraid, will fall flatter than AM stereo.

Bill Wolfenbarger
President, Jodesha Broadcasting Inc.
KSWW(FM)/KJET(FM)/KBKW(AM), Aberdeen, Wash.

Write to Radio World

Send e-mail to *radioworld@imaspub.com* with "Letter to the Editor" in the subject field; fax to (703) 820-3245; or mail to Reader's Forum, Radio World, P.O. Box 1214, Falls Church, VA 22041.

GET EVERYTHING UNDER CONTROL



- RS-232 Control of all RDL Switching Modules
  Examples include computer controlled switching of 4x1 and 2x1 audio, video and digital audio signals.
- RS-232 Control of Many OEM Products
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RS-232

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  Direct interface with RDL System 84 allows switching, mixing & routing 8 mono or stereo sources to 4 outputs.
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- Status Inputs from Eight Sources
  Examples include sensing contact closures from satellite receivers or from RDL audio or video detection modules.
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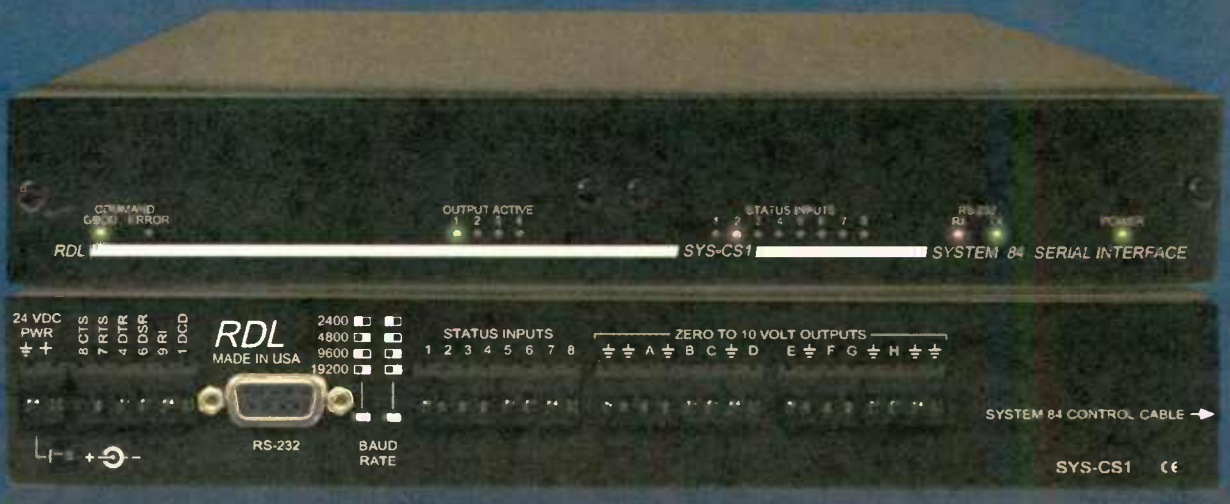

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Vernier

CONTINUED FROM PAGE 1

How did your career path lead you into radio management?

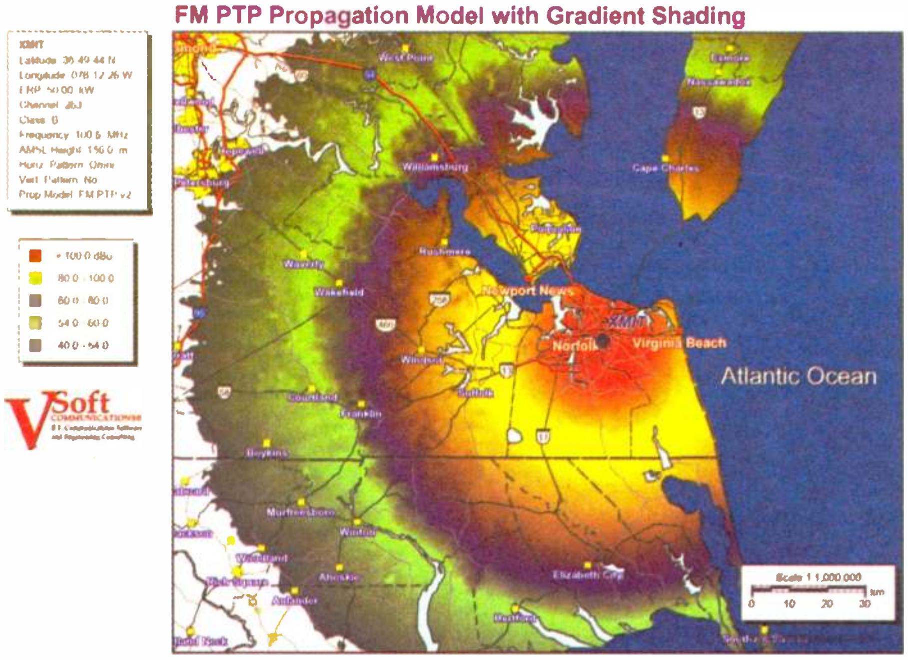
[illegible] AM DA stations [illegible] licensed operator on duty at all times. So, at the time, the easiest path to get on-air work experience at a real station was to become a "combo" jock. Stations wanted people who could sign the transmitter logs and talk on the air, because it was one less person they had to hire.

So my route into professional radio was via the First-Class license, which I obtained while attending college.

Between college degrees, I worked in Detroit for WJBK(AM-FM) in a management position. My title was director of advertising and sales promotion. The grandiose title was not properly reflective of the position, which was created from two part-time secretaries' positions. I was responsible for on-air contests, news releases and sales tools for the sales force.

Later, after finishing my graduate degree I took a job at Middle Tennessee State University, where I started its instructional program in broadcasting and put its educational radio station on the air. The station became qualified to receive grants from the Corporation for Public Broadcasting, which gave it a financial boost and helped to solidify my credentials in the public radio arena.

After four years with the MTSU I left to take a position of director of broadcasting services at the University of Northern Iowa where we created non-commercial stations KUNI(FM) and KHKE(FM), and a raft of repeater stations across Iowa.



PTP Map

How did that same career path lead to starting V-Soft?

While working at the University of Northern Iowa, two events came along that shaped my future. First was the advent of the personal computer. Second was the mid-'70s FCC's decision, with prodding from CPB and NPR, to require all 10-watt educational FM stations to increase their ERP to at least 100 watts or move to the commercial band where they would be secondary to full-service commercial stations.

At the time, I sent computer-duplicated "personal" letters offering help to the presidents of the colleges and universities that were affected. Thus began my moonlighting work as a consulting engineer.

What was V-Soft Communications' first product, and how did you develop it?

Before we called the company V-Soft Communications, I created a "computer"-automated FM frequency search progam for the RadioShack Model 1. Mind you, this was before the FCC used computers for this purpose. The program took about 15 minutes to load from a tape cassette into the 64 kilobyte memory.

It was slower than molasses, but it worked. I can remember showing it off to a number of folks including Richard Cassidy, who at the time was vice president of engineering at NPR. The word spread and before long I was receiving calls from consultants who had heard I had a computer program for doing frequency searches.

The first commercial program we sold was called SearchFM, which actually was the old Model 1 program ported over to the then-current Model 3 Tandy computers with the 10-inch floppy disks.

Early on, Vernier created a 'computer'-automated FM frequency search program for the RadioShack Model 1. The program took about 15 minutes to load from a tape cassette into the 64 kilobyte memory.

How did you grow V-Soft Communications, product-wise?

Our early goal as a company was to be a "full-service" software company for broadcast engineers and consultants, so we began to add programs that would do TV frequency searches and plot FCC coverage.

We developed a number of programs that integrated geographic mapping with coverage prediction algorithms. We eventually added an AM groundwave and skywave frequency search and mapping program to our product line.

What is your most popular?

[illegible] integrates FM [illegible] contour and spacing allocation features with sophisticated polygon mapping.

Our polygon mapping uses shapes — polygons — rather than lines to define map objects, so lakes and large rivers will be filled in with water-like colors giving [shape to the water bodies]. City boundaries and major highways also are filled in as shapes so that our maps have an atlas-like look.

How do you produce coverage maps that reflect "real-world" reception?

"Real-world" is a wonderful term that is kind of the nirvana of prediction efforts. We remind folks that *any* computer program that "predicts" coverage is just that, a "prediction." Kind of like looking into a crystal ball.

However, there are things you can do to make your predictions better reflect the "real world," and that has been at the core of our efforts at V-Soft: To accurately model RF coverage, you need to give the computer as much good information as possible about the "real world." For the VHF frequencies used in FM and TV, this includes the physical environment between the transmitter and the receiver. The better the accuracy of the terrain and land-cover databases, the better your predictions will be.

Then there is the modeling algorithm you select. Our programs give users the options to use standard FCC, which has some severe weaknesses, Longley-Rice, Terrain Integrated Rough Earth Model, Okmura-Hata, Cost 321-Hata, ITU.R P.1546-1, Point-To-Point and others. Each of these algorithms has its advantages and disadvantages, so it is left up to the user to know when it is best to apply one over the other.

Lately, new terrain elevation databases have become available and are now offered as V-Soft products. These include the USGS National Elevation Dataset 30 meter — satellite corrected — database and NASA's Shuttle Radar Topography Mission database. The former database has high resolution and accuracy, while the latter database includes tall buildings that may impact radio waves.

Many of us have seen the term "Longley-Rice Propagation." What does it mean?

In the mid-'60s, the National Bureau of Standards published Technical Note 101. P. L. Rice, A. G. Longley, A. Norton and A. P. Barsis authored this two-volume propagation treatise in the course of their work at the Institute for Telecommunications

SEE VERNIER, PAGE 8

Internet remotes... there's been talk.

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COMREX

Vernier

CONTINUED FROM PAGE 6

Sciences and Aeronomy at Boulder, Colo.

The concepts expressed in these documents were incorporated into a series of computer routines that came to be known as the "Longley-Rice Model." This model has recently been employed by the commission to determine the new DTV allocation scheme. It has now become the standard alternative prediction method.

Going well beyond the FCC curves, the Longley-Rice method considers atmospheric absorption including absorption by water vapor and oxygen, loss due to sky-noise temperature and attenuation caused by rain and clouds. It considers terrain roughness, knife-edge diffraction — with and without ground-reflections — loss due to isolated obstacles, diffraction, forward scatter and long-term power fading. Longley-Rice is fully integrated into our Probe 3 propagation prediction program.

What is the PTP propagation method?

The PTP propagation was first proposed in the 1998 Biennial Regulatory Review (Streamlining of Radio Technical Rules in MM Docket No. 98-93, 98-117). This proposed method was authored by Harry Wong of the FCC's Office and Engineering Technology. The method provides for an analysis of the entire path between the transmitter and receiver. It bases its process on radio diffraction and attenuation to the free-space path caused by irregular terrain entering the Fresnel zone.

According to Wong, the major determinants of this method include "the amount by which the direct ray clears terrain prominences or is blocked by them; the position of terrain prominences along the path; the strong influence of the degree of roundness of these terrain features; and the apparent earth flattening due to atmospheric refraction." The original code for the PTP method used the 30-arc-second terrain elevation database and applied a static 5 dB of attenuation at points along the path to represent urban clutter.

The commission chose not to adopt this method but reported that it planned to do more work on the model, modifying it to use 3-arc-second terrain and to provide for more flexible clutter calculations. Mr. Wong updated his method in an abstract available from the FCC, dated Nov. 1, 2002, where he reported that when compared with actual propagation measurements and the results of other prediction procedures, the PTP model's results were relatively accurate, and that the accuracy was as good or better than that of alternative prediction procedures.

When used with our Probe 3 program, the method can produce pools of coverage areas color-coded by signal level or a more traditional calculated contour line. To date, the commission allows PTP submissions only as alternate showings when accompanied by a showing using the regular FCC method.

"Desired to Undesired" studies can be useful in determining actual coverage. What is a "Desired to Undesired" contour study and is it acceptable to the FCC?

Often called D/U studies (and sometimes U/D studies) "Desired-to-Undesired" values are the signal-strength ratios between a "desired" station and "undesired" station. This ratio, when applied to signal contours, can establish when a receiver will pick up interference at a given location.

The ratios were developed in 1947 by the FCC under Project #22231. The FCC "Laboratory Division" conducted tests on FM radios and published reports on "Characteristics of Commercial FM Broadcast Receivers," so the ratios the FCC uses today to protect stations from interference were developed from vacuum-tube FM radios using dated discriminator technology.

The V-Soft Communications team. (L-R): Doug Vernier, president; Gayle Vernier, bookkeeper; Kate Michler, technical consultant; Adam Puls, technical support and marketing specialist. Not pictured: John Gray, director of R&D.

Included in the project were tests concerning the interference rejection ratios on both co-channel and adjacent channels. These measurements were the basis for the interference ratios used in the current FM rules, first adopted in 1951.

To answer your second question, yes. To this day, the commission requires allocation studies that plot out the F(50-10) interference contour of the applicant's station, and the F(50-50) normally protected contour of those stations having a frequency and distance relationship, for short-spaced commercial stations, non-commercial educational and FM translator station submissions.

These contours are not supposed to cross. If they do, you have a measure of interference within the enclosed areas of the contours. The values of these contours are based on the FCC's D/U ratios.

These same ratios often are used under the Longley-Rice model to define the predicted location of interference. Such Longley-Rice studies can be presented to the FCC as "alternative showings."

Do you provide studies that are acceptable to other countries, such as Canada and European countries?

Yes, V-Soft has recently completed a Canadian version of FMCommander that uses all the Canadian rules. In fact, Industry Canada, the Canadian governmental telecommunications regulator, has purchased our Probe and AM-Pro programs to use in regulating AM, FM and TV broadcasting in Canada.

The Canadian Broadcasting Corp. also is one of our AM-Pro clients. Most European countries use the ITU criteria for regulatory proposes. Our Probe program incorporates this propagation model.

Are you anticipating the ability to plot the digital coverage vs. the analog coverage of IBOC AM or FM stations?

Yes, we are keenly observing current testing projects that will establish real-world sensitivity and selectivity D/U values for IBOC receivers. Once this information is in hand we can accurately predict IBOC coverage and interference.

How do you feel about the feasibility of using calculated AM directional "proofs" rather than field measured "proofs"?

Not very good. There are too many things that can impact an AM directional station's coverage, including that new trailer court that has moved in next to the array, or the rat colony in the ATU that has changed the operating parameters of a station. I think we need to continue the measuring process to assure our AM DAs are protecting the stations they are required to protect.

What future products would you like to offer your customers?

Just last month we completed a program called "Conductivity," which has been a hit with AM engineers who take field readings and need to graph them to determine which ground conductivity values to apply. The program can be used to show the FCC that, based on field readings, the ground conductivity differs from the standard M3, therefore allowing certain AM stations to increase power in certain directions.

We are working on a microwave frequency search program at the present time and we will be developing a program that automatically calculates the array parameters for multitower AM stations given certain allocation restraints. As always, we are working on new upgrades to our existing set of programs that will offer even more features and user conveniences.

Comment on this or any article. Write to rwee@imaspub.com.

Steve Callahan is the assistant chief engineer for the WBUR Group in Boston. He interviewed Roy Stype of Carl E. Smith Consulting Engineers in the April 5 issue. ■

"Connect POTS to ISDN? You've got to be kidding!"

At Telos, we're obsessed with quality audio. We were the first to marry DSP with broadcast phone hybrids to achieve clean, clear caller audio. We invented Zephyr, Earth's most popular way to send CD-quality audio over ISDN. And now our DSP experts have built the **best-sounding POTS codec ever — Zephyr Xport.**

Instead of proprietary algorithms, we chose **MPEG-standard *aacPlus*®**, the same coding used by XM Satellite Radio, Digital Radio Mondiale, Minnesota Public Radio, Apple Computer and many others to deliver **superior audio at low bit rates.** (An optional ISDN interface lets Xport connect to Zephyr Xstream with Low-Delay MPEG AAC, or with nearly all third-party ISDN codecs using G.722.)

There's no need for a studio-side POTS line. Your studio's Zephyr Xtream receives Xport's POTS calls via its existing ISDN line, **eliminating the cost of a second POTS codec** and delivering smooth, clear digital audio to your listeners.

And Xport **makes unexpected modem re-training extinct** thanks to custom DSP algorithms that extract stable performance from even marginal phone lines. Xport gives you **surprisingly clean 15 kHz remote audio at bit rates as low as 19 kbps.**

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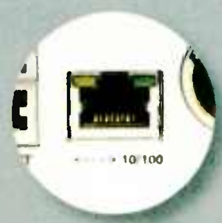

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Focus

CONTINUED FROM PAGE 1

others to lead them or set an example.

We'll go through six major areas of focus for an engineering supervisor, discuss guiding principles and share tips to help you.

STAFF ACQUISITION

Hiring people for your team can be one of the most important decisions you'll make as a leader in the engineering organization. You need to be able to verbalize what kind of people you want on your team before you can go out and look for them.

The main limitation is the amount of compensation you are authorized to offer prospective candidates. There's nothing wrong with emphasizing the non-monetary benefits of joining your team. Respect as professionals, just and fair treatment, recognition and reward for achievement and personal and professional growth are reasons someone might wish to join your team.

Square pegs in round holes won't work in any position within an organization. Don't place staff who lack human relations skills in positions requiring interaction with other departments. People who are short on tact and grace require coaching and training. It is your duty as a leader to put pieces of the puzzle in their proper places.

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Lintag says if you don't define the level of quality you want out of your engineering department, you won't get it.

Your active involvement can lead you to the right people. Become involved in engineering societies such as the SBE, where you can get to know qualified engineers and technicians. Professional networking will lead you to referrals and save you the time and expense of posting classifieds.

Hire for attitude; train for skills. Attitude is everything in an organization. A teachable attitude indicates a great team player, whereas a sour attitude is a promise of failure. Worse, poor attitudes multiply faster and easier within the organization compared to the behavior you want others to duplicate. Beware of smart alecks and superheroes who typify Don Quixote and undermine the efforts of the team.

Aptitude is what keeps one going, and you can't expand on something that isn't there. A person needs to have the ability to assimilate learning and build on his experience and knowledge to become familiar with your particular broadcast system. Our technology moves at a pace that can leave many behind if they don't have the right learning curve for the job. Certifications and continuing education can help you gauge a candidate's aptitude.

BROADCAST OPERATIONS

Our broadcast operation is our daily rote. We are so accustomed to it that it appears to be the only thing that matters in the engineering department.

This is true in the sense that revenue will not come into the station if our signal is not on the air. However, this can become an activity trap. We may not find time to reflect on how we are doing and what exactly we want to accomplish. As you may find, activity and accomplishment are different things. We'd better understand the difference before the consequences affect our performance adversely.

A Standard of Performance, or SoP, should guide our broadcast operations. We need measurable parameters by which to gauge the effectiveness of our on-air signal with respect to quality and consistency.

The SoP is the yardstick we use to determine if we are hitting the mark on a daily basis. Any deviation from this standard requires appropriate action from us, which later may form part of our operational policies and protocols.

New operators should know one standard to observe: There should be no dead air for a definite period of time, for example three seconds. Another standard is that audio should be consistent in level even during commercial breaks.

Treat instances in which the standard is not being met as discrepancies. If you don't define the quality you want, you won't get it.

Involve your people. In one of your staff meetings, solicit the contribution of operations personnel as to how your on-air signal should look or sound. Build on their ideas in order for them to "own" that signal and commit themselves to seeing that their "ideal" signal is achieved. The description of their ideal has to be measurable so everyone understands how far you are from achieving it.

Institutionalize activities where your staff will learn to know each other more than just as "workmates." Once-a-month meetings can strengthen the team spirit, helping them feel more accountable to each other for achieving the objectives.

MAINTENANCE

Maintenance is an important engineering function that may not receive adequate attention from the department. Often it is defined incorrectly as just corrective maintenance, which is more concerned with "reacting" to equipment failures rather than preventing them. Take deliberate efforts to develop a Preventive Maintenance program in order to take care of this concern.

Personnel need to develop the habit of "preventive thinking." A number of equipment problems can be prevented from occurring and recurring if station personnel are conscientious of their actions as they perform their routines.

Make it a rule that parts replacement must use the exact part as specified by the OEM. Shortcuts and substitutes may not be good for the long-term health of the equipment. Fault-finding can be a good trait when focused on broadcast equipment rather than people. You should be able to see, smell or hear that a problem is brewing and be able to act accordingly.

A maintenance program that does not improve over time may no longer be relevant to the condition of the equipment. A number of parts may have deteriorated and need extra attention but may not be part of the program being implemented. Take steps on a regular basis to update your maintenance programs as to scheduling and activities.

Documentation of maintenance procedures and symptoms observed on the equipment is critical. The maintenance team must be able to determine if a particular problem on the equipment is design-related or the result of factory defects. These problems can only be established with a good documentation procedure.

Ensure that the staff is briefed on how to create the documentation. Keep in touch with manufacturers because retrofits may be available for the asking.

PROJECTS

Projects are exciting, a welcome diversion for operations and maintenance personnel. However, project activities can rob the department of man-hours needed for operations and maintenance. Should you decide to do projects in-house, decide how much involvement you want for your staff.

Before launching a project, allow the people who will operate and maintain it to offer their input. Operational problems can be avoided if your project team consults with the operations and maintenance staff.

Progress reports with landmarks defined and documented are essential in keeping leadership informed. These also serve as a reference in the future on what the facilities look like when first put up. Test data during commissioning and field intensity measurement reports have to be filed for reference later by operations and maintenance staff. "As-built" plans should be provided in software copies to allow future updates of the drawings.

SEE FOCUS, PAGE 12

by Blažo Guzina

Controlling Volume Requires Eyes, Ears

Board Ops Monitor Loudness Visually With PPM, VU Meter Readings, and Audibly With the Human Ear

Blažo Guzina is a senior engineer at Radio Televizija Srbije in Belgrade, Serbia.

Among many things in a radio station that occasionally may get out of hand, the level of recorded or broadcast signal can vary unexpectedly.

For this reason, controlling program volume is the most important task of a board operator, who performs the job both subjectively by ear and objectively by observing the scale of a program level meter.

Because level metering cannot perfectly match the subjective feeling of loudness, it is essential to use meters only as a guide and to rely upon the ears as the final arbitrator. This is the only way to balance one voice against another, loud music against quiet passages and speech against music in general.

VISUAL MONITORING

Subjective assessment of program loudness is important particularly when control is by means of a PPM level meter. A peak program meter can mislead an operator by indicating signal peaks in programs where high peaks are combined with a relatively low average level of a signal.

On the other hand, a VU or volume unit meter reads the root mean square (RMS) level and ignores instantaneous peaks that do not contribute to loudness. Ignoring the short-term peaks can result in an overload of tape and over-modulation of the transmitter.

Nevertheless, visual monitoring by means of program meters is indispensable because, between the studio and transmitter, the broadcast signal passes through many pieces of equipment that must not be overloaded.

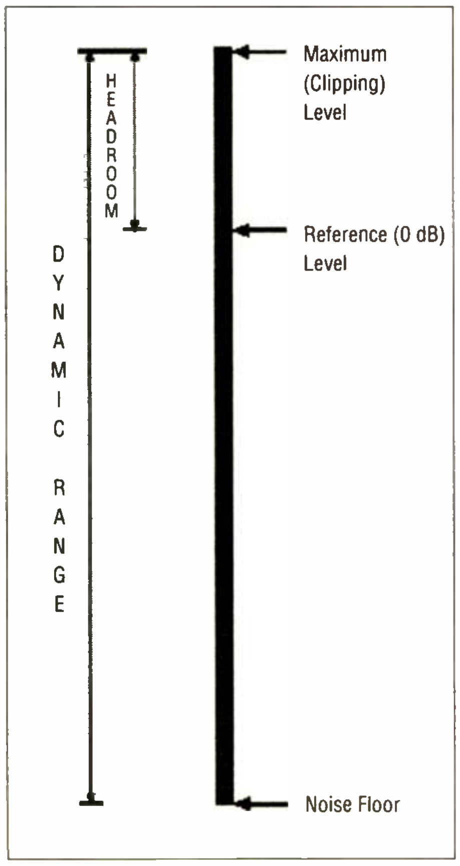

Fig. 1: Available Dynamic Range of an Audio Signal

Visual monitoring is used for checking levels in order to prevent under- or over-modulation of transmitter or recorder; for checking that there is no loss or gain in level between studio, control room, transmitter and other output lines; for comparing relative levels between one type of program and another; and, finally, for meeting the prescribed values for good listening.

Controlling the signal level in an audio system is based on the general rule that it is necessary to keep the signal as high as possible so as to ensure maximal protection from the influence of interference and noise that is always present in the system.

At the same time, signals must never exceed the maximum level that electronic circuits and analog-to-digital converters are able to withstand.

Therefore, some maximum amplitude limit must always exist. Controlling the signal level relies on a reference point on the level scale, defined as 0 dB, which allows monitoring of the effective signal value with the use of a program level meter.

PERMITTED OVER-READING

So what is the permitted amplitude over-reading that exceeds the reference 0 dB level? There is no general answer to the issue because it depends on the type of audio equipment in use.

However, there is a clipping level at which the electronic circuitry cannot withstand the highest peaks in the signal waveform. The audible effect of clipping is an annoying sound caused by non-tolerable distortions.

The difference in decibels on the signal level scale, between the clipping level and the adapted reference (0 dB) level, is known as headroom. The headroom and available dynamic range of audio signal are shown in Fig. 1.

The level of noise, at the lower end, and the maximum level at which the clipping occurs, at the upper end, determine the margins.

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Focus

CONTINUED FROM PAGE 10

TRAINING AND DEVELOPMENT

Provide a clear career path for your technical personnel. Define the requirements that will allow a person to move from one level to the next. This is where training and development can help your staff to move up. When you succeed in making this a part of the promotion or recognition process, your staff will be motivated to improve their technical competencies.

Every engineer should get hooked on reading. Route to staff those reading materials relevant to their work; this will help them stay abreast on technology. Supervisors need to study extra by reading about how to develop people skills and leadership and management techniques. Remember, "Leaders are readers of leaders." Take advantage of free Web seminars and other training tools.

The best way to invest time with a particular person is by showing him how to do a task personally on a one-on-one basis. Encourage and develop this "show and tell" culture within your department so that the know-how is shared.

Establish a means to certify the competency of any person within the department. Every training program needs a means to evaluate the acquired skills of the people and have them certified accordingly.

COMMUNICATIONS

Engineers can be perceived as lacking grace in written and oral communications. This perception need not be true, especially as we move through the ladder of corporate leadership.

Engineering leaders can be seen as ineffective if they cannot adequately express themselves orally or in writing. This area is important, even critical at times; we cannot leave this to chance. Deliberate efforts to keep staff informed should be a daily preoccupation of engineering leaders.

The leader should ensure proper and immediate understanding within his department. Miscommunication during operations can be costly to the company, especially if it takes the form of lost commercials or off-the-air conditions. Decide exactly what you want the other person to know and then say it clearly.

Good relationships help a lot in communication, so build them. There are things that are best said face-to-face rather than over the phone or via e-mail. Facial expressions and eye contact can convey goodwill and should be used for important communications.

Engineers face the challenge to communicate adequately and clearly with non-technical people. As we go on with the performance of our daily duties, we are faced with the task of explaining technical problems or scenarios to laymen. The situation is complicated by the fact that employees in other departments usually exhibit far different personality traits than we do.

We need to be aware of our differences in communication styles in order to relate with others. Only then will others be able to relate with us and consequently understand what we want them to know. How other departments perceive us is a vital parameter of how well we do our job.

Plan for and evaluate these areas of concern regularly with your engineering team. You'll find later that you have better control of the results. ■

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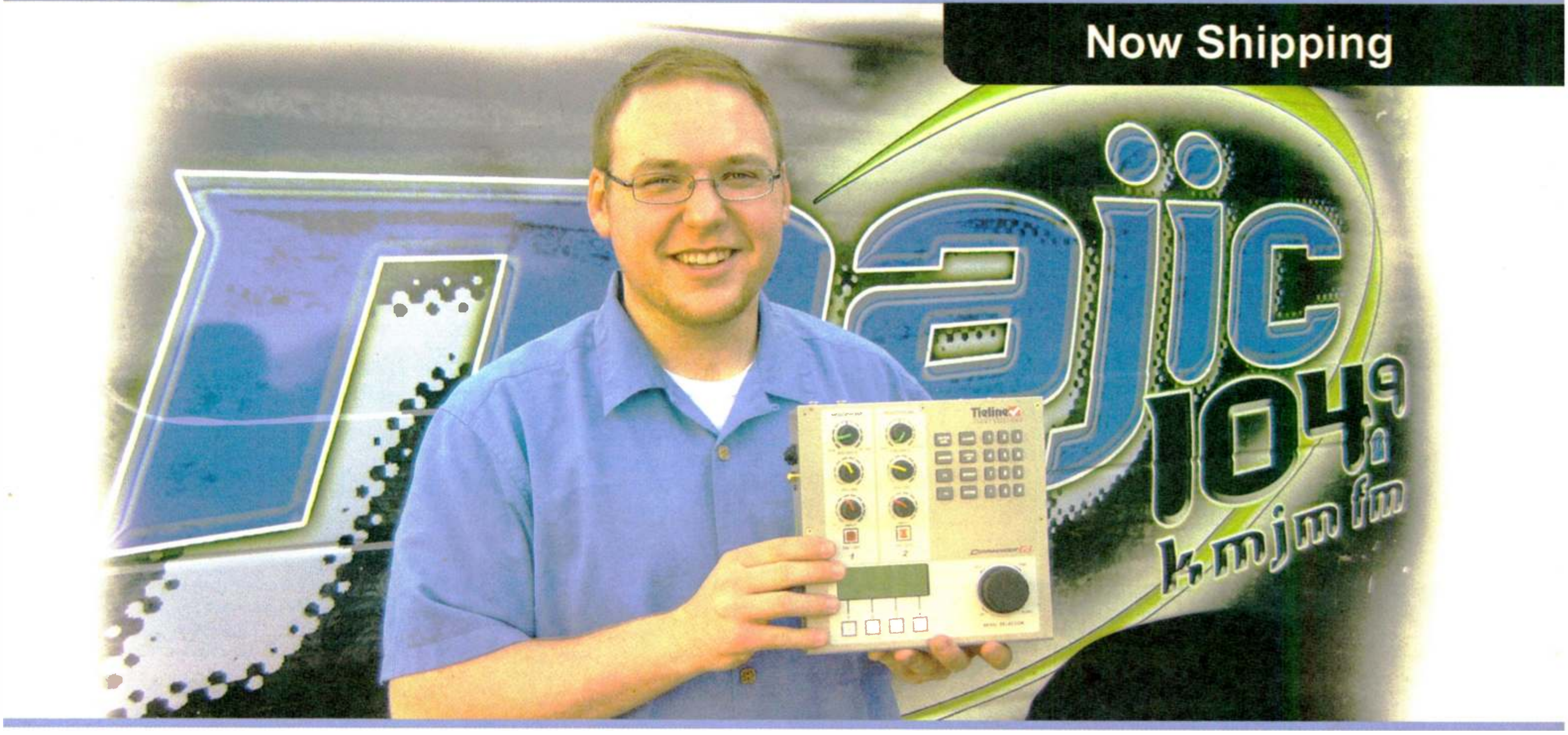

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by Alan Rauchwerger

Absorbing, Calculating Damping Factor

Why Dynamic Speaker Users Should Understand DF, The Measure of an Amp's Speaker Control Ability

Alan Rauchwerger is president of Virtual Image Inc. in Rochelle Park, N.J.

It's 1970. An audiophile hooks up his Klipsch Cornwall speakers to a Crown DC-300A amp; there is no bass from the 15-inch woofers. Later he switches to an ARC tube amp; now he has tons of quality bass.

It's 1984. An audiophile hooks up his Pentagram P10 speakers (containing passive radiators to augment bass) to a Phase Linear 400 amp. You can hear the woofers stop on a dime, while the 15-inch passive radiators continue to flop around. With a tube amp, the woofer and passive work together.

It's 1990. An audiophile tries a vintage tube amp on his high-end speakers. The bass becomes muddy and uncontrolled. With his solid-state amp connected instead, the bass is clean and controlled.

What do these three incidents have in common? The problems were all caused by inappropriate damping factors and were solved by using amps with appropriate damping factors.

Let me begin with a disclaimer: I've been a rabid audiophile since the late 1960s, and I use electrostatic speakers that don't require electrical damping. That said, let's take a look at damping factor; what it is, what it can do, how to calculate it and why it's important to users of dynamic speakers.

DO THE MATH

The concept of damping factor is not widely understood. In simple terms, damping factor, or DF, is a measure of the ability of an amplifier to control a speaker. The speaker's own suspension and type of bass loading (bass reflex, acoustic suspension, passive radiator, etc.) determine the amount of control needed.

As the speaker moves, it generates a voltage of its own (back EMF), in accordance with Lenz's Law. Just as shorting its output makes a generator harder to turn, low impedance across loudspeaker terminals creates an electromagnetic braking effect. Damping factor is more important in controlling massive, high-compliance woofers.

The simplistic formula for damping fac-

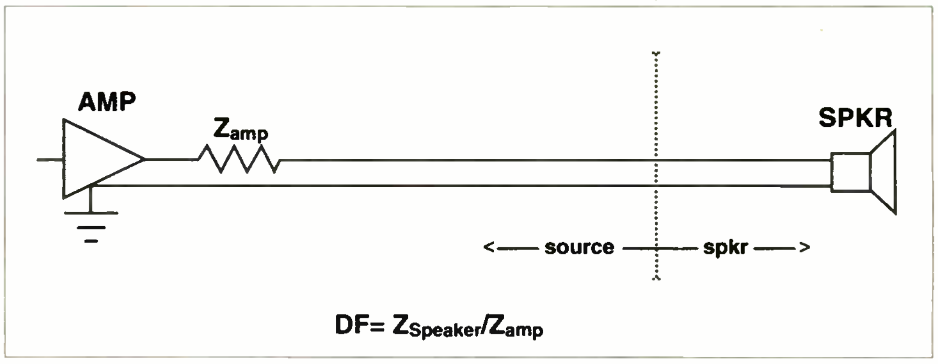

Fig. 1: Simplistic DF Diagram

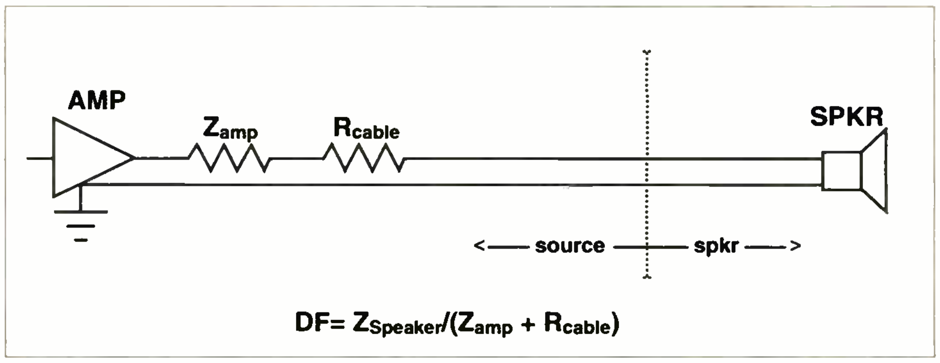

Fig. 2: More Realistic DF Diagram

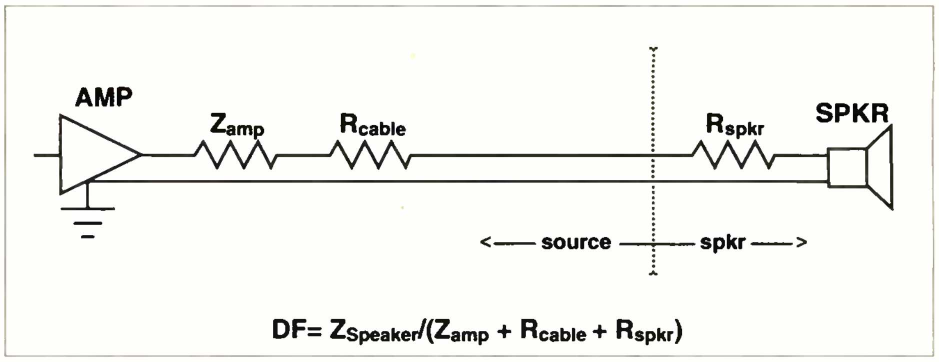

Fig. 3: DF Diagram Including Speaker Resistance

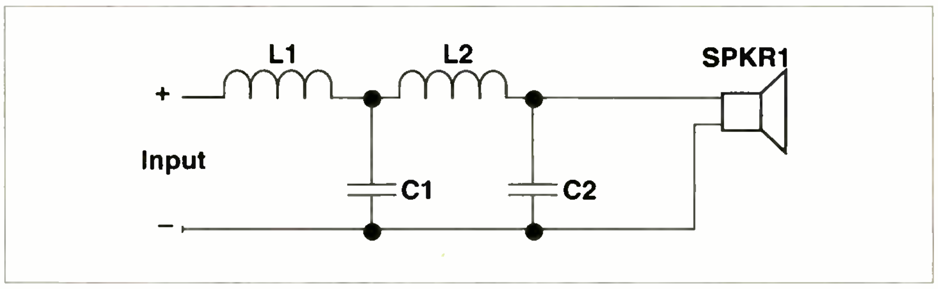

Fig. 4: Typical 24 dB/Octave Speaker Crossover

tor is speaker impedance divided by amplifier output impedance, or

$$DF=Z_{speaker}/Z_{amp}$$

(see Fig. 1). This is the formula an amp manufacturer would use when stating the DF of their amps, generally rated at 1 kHz. As both impedances are in ohms, DF is a pure number with no units. DF is a meaningless number unless speaker impedance also is specified.

This formula is too simplistic because it does not take into account the resistance of the speaker cable (R_{cable}). A more realistic formula is

$$DF=Z_{speaker}/(Z_{amp}+R_{cable})$$

(see Fig. 2). For illustrative purposes, let's assume the impedances all are resistances, as they can then be added directly. If your amp has an output impedance of .1 ohm, and your cabling is .1 ohm, the DF into an eight ohm speaker is 40 (8/.2 = 40). Note that in this example the cabling cuts the DF in half, as opposed to the simplistic formula.

This brings up an important point. Some amplifiers have DFs as high as "over 3000" into eight ohms. A DF of 3000 represents an output impedance of .0026667 ohms. A 10-foot run (20 feet round-trip) of 12-gauge speaker wire has a resistance of .0318 ohms (over 10 times the amp's impedance). This reduces the DF to 232. Using the thin, 20-gauge so-called speaker wire often thrown in with systems would give .202 ohms, cutting that 3000 DF to 39.

Let's see what would happen with an amp with a DF of 300 under the same circumstances. Its output impedance would be .026667 ohms. With 12-gauge wire,

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DF

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DF into eight ohms is 136; with 20-gauge wire, DF is 34. In this example, the 20-gauge wire affects DF a lot more than the amps do.

In the real world, neither speakers nor amps have constant impedances, so the DF will vary with frequency. There is no consensus on how much DF is desirable. Some opinions deem a DF of 10 totally adequate, while others find DFs as high as 30 inadequate. DFs above 100 are generally considered very good to excellent.

As stated earlier, though, the damping needed depends on the speaker design. For example, the Klipsch Cornwall is a speaker with a stiff suspension and requires little electrical damping, as it was designed with low DF tube amps in mind.

While researching this article, I came across several references to the fact that an 8-ohm woofer may have a DC resistance of 6 ohms or so, and opinions that it must be included when computing DF. In other words, one should consider there to be a 6-ohm resistor in series with the cable resistance (Fig. 3) and the 5.29-ohm reactance (X_{spkr}) of the speaker. Impedance equals the square root of resistance squared plus reactance squared.

For that matter, one could make the same argument about the inductor(s) in the crossover that are in series between the amp and woofer (L1 and L2 in Fig. 4). While true, this doesn't negate the importance of DF; it merely defines the limit of the electrical damping effect. It does mean, however, that the effect of the DF will not be linear; twice the DF will not stop the woofer twice as quickly.

Increasing the DF by lowering cable resistance and amp impedance offers a dividend unrelated to damping. A high-impedance source tends to increase frequency response anomalies as the speaker's impedance varies with frequency. Figs. 5a and 5b show the frequency response of a solid-state amp and a tube amp when connected to a loudspeaker or an 8-ohm resistor. You can barely see the almost straight line on each graph at the 0 dB mark representing frequency response into the resistor.

The tube amp causes variations of more than one dB, while the solid-state amp varies less than a quarter of a dB from 20–20,000 Hz. It's obvious that minimizing source impedance results in less frequency response modification.

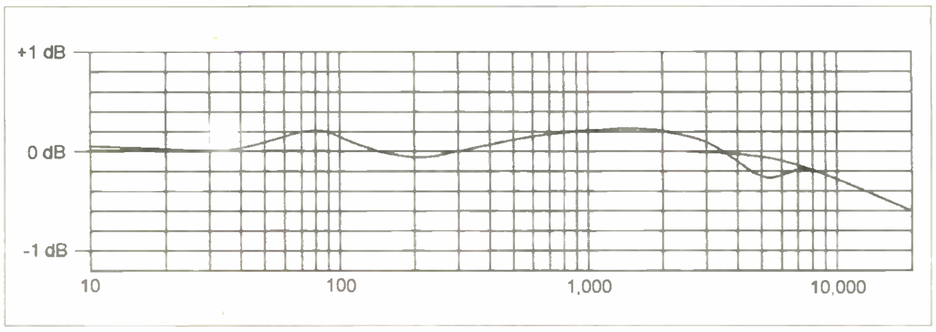

Fig. 5a: Solid-State Amp (Z_{out} = .25 ohm)

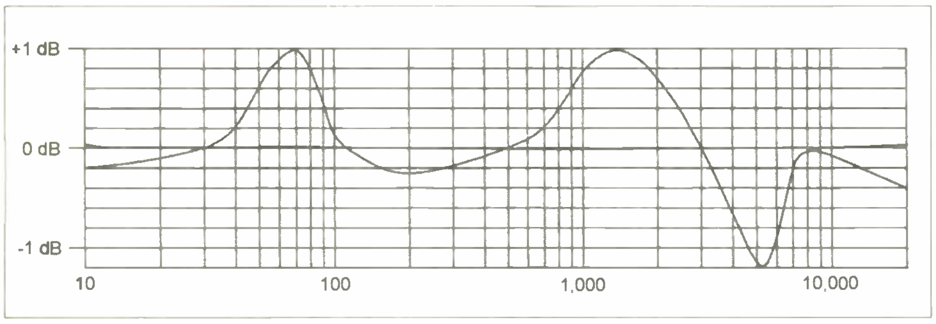

Fig. 5b: Vacuum Tube Amp (Z_{out} = 1.8 ohms)

An interesting paradox is that, from the speaker's point of view, the resistance of the speaker cable is seen as part of the source (amp) impedance; but from the amp's viewpoint, the speaker cable is part of the speaker's impedance.

Now that you understand damping factor, I'll explain the three examples at the beginning of the article.

First up is the Klipsch speaker. The lack of bass was caused by the fact that it takes time to get a massive 15-inch woofer moving, and the Crown amp has a high DF. Essentially, as soon as the woofer started moving, the amp made it stop. Too much DF stopped the woofer before it started producing audible bass. The lower DF of the tube amp allowed the bass to emerge.

Second, the Pentagram speaker's relatively leaky cabinet reduced the desirable coupling between the passive radiator and woofer. The solid-state amp made this obvious due to its high DF putting the brakes on the woofer but not the poorly coupled passive radiator, while the tube amp had just the right DF to let the woofer and passive coast to a stop together.

The high-end speakers of the 1990s were a modern design with little mechanical damping. They depended on the amp to keep their woofers controlled. The DF of the vintage tube amp was not up to the task; the DF of the solid-state amp was.

Comment on this article; e-mail rwee@imaspub.com. ■

MARKETPLACE

Innes Corp. Debuts 6-, 24-Station FM Capture Cards

Innes Corp. added six- and 24-station FM stereo capture cards to its line of AM capture products.

The AM and FM Radcap are capture cards for simultaneous recording of multiple radio stations. The frequency of each station may be set in software and its audio appears as a standard Windows audio input device. The company says the cards were designed for use in its Flashlog 5 hard-disk recorder but found a market with radio stations and media monitoring companies.

The 24-channel FM Radcap uses four six-channel digital-down-converter chips, each incorporating an on-chip A/D converter that digitizes the FM band, and digital filtering to extract each channel. The company says the driver software uses the processor's SSE multimedia instruction set to demodulate each channel and perform the stereo decoding. A lower-cost six-channel version uses a single digital down-converter.

The AM Radcap uses a high-speed analog-to-digital converter to digitize the AM band, and extracts the audio for each station in software using the MMX instruction set of the PC's processor. This card is available in standard configurations of eight, 12, 16 and 20 channels.

FM Radcap

A WDM driver for Windows 2000, XP and Server 2003 is supplied with each card, along with software for setting the tuner frequencies and monitoring the received audio. A programming API to allow application software to control the cards is included.

The six-station capture card retails for $1,595; the 24-station version retails for $2,980.

For more information, contact Innes Corp.'s U.S. dealer Broadcast Depot in Miami at (305) 599-3100 or visit www.innescorp.com.au.

by Greg Massey and Jon McClintock

Packet Size Matters in IP Transport

A Look at Sending Audio Over IP Via Packets, and Network Considerations Such as Latency and Jitter

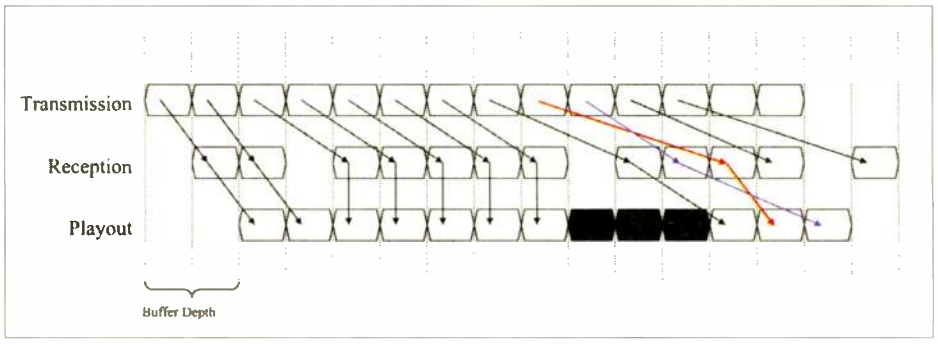

Fig. 1: Network Jitter Effects

Greg Massey is the chief technology officer for APT; Jon McClintock is the commercial director.

Transporting broadcast quality audio over IP is the new "must have" technology for radio and TV networks. However, IP as a transport mechanism has a number of inherent characteristics that could potentially pose problems for codec manufacturers and broadcasters alike.

While massive IP bandwidth is now available, it comes with some caveats. These include:

- The packets do not always arrive in the order in which they where sent.
- The transport protocols introduce a natural delay to the link.
- Dropped packets are always a possibility.
- Bandwidth is not guaranteed.
- Packet delays through the network are variable.

Manufacturers already have put in place methods and protocols to cope with the plethora of issues surrounding audio over IP, including forward error correction, concealment and security mechanisms.

Experience also has shown that the use of MPEG derivatives in contribution and distribution networks has resulted in almost unusable coding delays and serious degradation of audio quality. The layering together of the inherent delays associated with MPEG and IP will create an impossible scenario for any broadcaster wishing to put live content on-air.

This paper aims to explore the audio coding technologies available, and explain why the Enhanced apt-X algorithm benefits the broadcast community with a solution that maximizes the benefits of IP, retains acoustic integrity and ensures the coding delay is reduced to a workable value, i.e. under 20 milliseconds.

IP NETWORK CONSIDERATIONS

Latency

Networks have transport latency due to the natural laws of physics. Transporting an electronic signal through whatever medium takes a finite amount of time that cannot be removed.

In a switched network we must contend with both the standard transmission delay and also the packetizing delay. By definition, a packet must be assembled and consists of a header plus payload. The size of that payload can be varied but ultimately it consists of an audio sample.

Lost packets are a fundamental feature of switched networks and something that audio codec designers must learn to live with or suffer the consequences

Take for example a system that uses a four-to-one compression algorithm and has a packet size of 128 bytes. That's 512 audio samples, equal to 666 microseconds in mono and 333 microseconds in stereo. Then take the time it takes to propagate through the UDP stack after being assembled into a Real-time Transport Protocol packet. In real, live-unit tests this is approximately 20–30 milleseconds.

It is important to realize that this natural latency increases as the sample frequency decreases. With this inherent latency in the protocol stack the additional delay of the audio coding is critical in real-time audio applications.

Lost packets

Lost packets are a fundamental feature of switched networks and something that all audio codec designers must learn to live with or suffer the consequences. Losing an audio packet quite literally translates into losing audio, which is a major problem in the broadcast environment.

Several solutions exist, ranging from ignoring the problem to masking it through to retransmission. If one discounts ignoring the problem as a solution, what remains are the masking and retransmission scenarios.

Packet size

As with all packet-based systems there is a tradeoff between the size of the packet, the processing overhead and network traffic/congestion.

Smaller packets increase overhead with the additional byte required to populate the packet header. Smaller packets are transported through the network at the same speed but an entire packet can be received more quickly due to its size. The difficulty with smaller packets is the increased likelihood that a packet will be lost or received out of sequence.

Larger packets have the opposite problem once they exceed the Ethernet limit of around 1500 bytes. The packet is then fragmented and transmitted in two or more parts, before being re-assembled at the opposite end. This complicates the receiver with no real benefit.

UDP vs. TCP

Transfer control protocol, or TCP, is a command and response architecture that guarantees delivery through an exchange of information between sender and receiver. This interaction requires time and has proven unworkable for streaming applications requiring low latency or real-time operation.

User datagram protocol (UDP) is simple send/receive architecture with little in the way of payload protection or guaranteed delivery. It does, however, lend itself to streaming applications since there is less processing delay on the protocol.

Jitter

These are packets that are received either side of the predicted arrival time. This is a feature of packet switched networks given that any packet can take any route from source to destination. Thus packet jitter will affect the way in which the receiver must handle the data sent.

Packet arrival jitter can be significant and can amount to several seconds depending on the network. The buffer depth is therefore critical in allowing the codec to provide enough time for the packet to be received and decoded before its playout time. Reducing the buffer size reduces the jitter time mask available and increases the potential of being forced to drop packets that have arrived beyond their playout time.

Fig. 1 shows the effect of network jitter on the reception of audio and its subsequent playout through an audio system. The buffer depth is usually set in milliseconds; in this case it is set to a two-packet buffer. For the purpose of this example, this allows for up to a two-packet jitter delay in the system.

Provided the network jitter is low, the system is unaffected and plays out the packets received in sequence. However, should the jitter increase, there is the distinct possibility that the packets will arrive after the determined playout time. In this example the packets have to be dropped, which results in the audio being corrupted.

CORRECTION/CONCEALMENT

Overview

No Forward Error Correction is currently used in the UDP packet, which makes it susceptible to bit errors. It does, however, speed up the processing, as this additional correction stage is bypassed.

Forward error correction also has implications for end-to-end systems. For example, to what extent should the FEC correct the errors, i.e. all or just partially? Alternatively, does a failure indicate that a retransmission should occur?

Concealment

Assuming retransmission is not practical, then the decoder must implement some type of concealment to prevent or conceal audio loss (see Fig. 2).

Various methods can be used to conceal errors in the final reproduction of the audio due to packet loss. They range from simple

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repetition of the last good packet received, to silence/noise injection, or interpolation and retransmission. All have an impact on the reproduced audio.

In listening tests the injection of silence produced unacceptable breaks in the audio that led to a level of incoherence. The use of white noise improved the intelligibility of the reproduced audio but was again noticeable. The use of repetition of the last known good frame produced favorable results. The use of interpolation/pattern matching/waveform substitution to conceal the loss of packets is possible but the benefits vs. complexity are governed by a law of diminishing returns.

The results of these techniques are all governed by subjective improvements in audio quality and are also subject to the amount of audio lost that is being concealed or repaired.

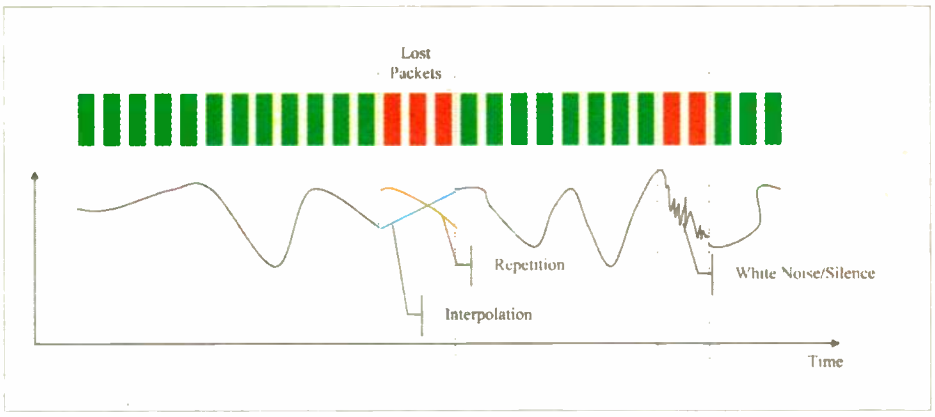

Fig. 2: Packet Loss Concealment

Correction

The use of Forward Error Correction to ensure packet recovery can be effective in audio streaming applications but it has implications for real-time applications due to the processing and data overheads associated with FEC algorithms (see Fig. 3).

The determination of how much FEC to use has to be related to the losses experienced with the medium being used, as adding more overhead to a heavily congested medium may exacerbate the situation. Also, the scheme used must be tailored to the type of loss being experienced. For example, is the FEC designed to correct burst packet loss, or a percentage of lost packets if the packets, which are lost, are non-consecutive?

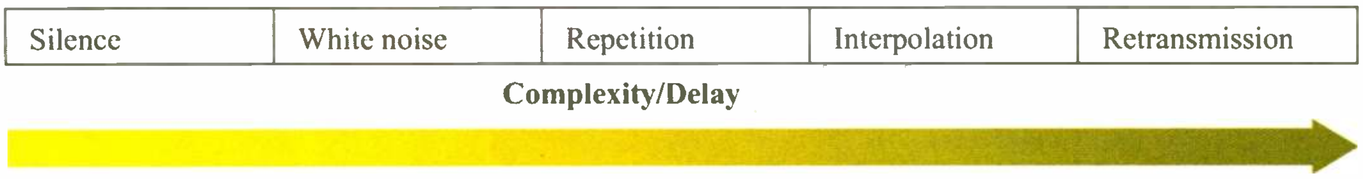

Fig. 3: Perceived Audio Quality

FEC Techniques Comparison

To maintain compatibility and interoperability between codecs the FEC information should be sent via a separate port so that the audio codec does not become confused if it cannot handle the FEC scheme.

Technique	Overhead	Complexity	Scope
FEC per n-I packets	Low	Low	Uniform Loss No Burst Recovery
FEC packet per packet	Low	High	Full recovery possible
FEC packet per n packets	Med	High	Burst loss recovery possible depending on scheme Increased delay

FEC Techniques Comparison

Clock skew

Assuming data is received from a central master unit, then each slave receiving the stream must adjust its playout to match that of the master, otherwise the buffer will either overrun or under run. While this can be done easily, problems can occur in multicast and multiple unicast (see Fig. 4).

In a simple network setup there is only one master and many slaves. IP makes it possible to send and receive audio feeds to and from anywhere in the network. The difficulty is that each sender and receiver has a different master clock; if they are sending at their basic rate they will eventually over-run or under-run the buffer.

This is further complicated if multiple streams are being received from different sources. It implies that each stream must be monitored and the play-out adjusted to track the master clock.

More basic systems ignore this and simply have a strategy that allows for over-run and under-run to occur before restarting the system.

Retransmission

This has implications for the real-time operation of the unit given the processing delay and use of Transmit and Receive buffers. A retransmission must insert the retransmitted packet into the buffer at the appropriate point (see Fig. 5).

RTCP feedback can be used to signal to the sender that packets should be retransmitted. There are benefits and problems associated with the retransmission of lost packets.

The primary advantage of retransmission is the ability to completely correct lost data. This is very effective for small groups and one-to-one streaming.

Disadvantages of retransmission include an increase in transmission overhead and increased latency. Since packet loss is generally due to high network traffic, retransmission will tend to exacerbate the problem and lead to more losses. Further, retransmission causes an increase in latency as the lost packets are sent, an error message is returned, and then packets are resent for a total of three trips over the network to receive the data. This makes systems using retransmission unsuited for real-time applications.

In networks using multicast or multiple unicast the retransmission of packets from multiple sources will contribute a substantial overhead to the network traffic and may also swamp a single sender unit if all slaves request retransmission of a single packet.

The latency of the compression algorithm then becomes an imperative when considering the design of a broadcast network.

If retransmission strategies are used in real-time applications to ensure no audio dropout, then they will have to incorporate enough buffering to compensate for all possible packet-loss scenarios.

Audio Algorithms

Having thoroughly investigated the intricacies of IP as a method of moving program content from Point A to Points B, C and D and through to Point X, the next step is to look at the best method of layering in audio on top of the transport stream.

In essence there are two options — PCM/linear or using compression to reduce bit rates. Within compressed there are two sub-options, perceptual or ADPCM.

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IP

CONTINUED FROM PAGE 20

PCM or linear audio is well defined in terms of the audio; what you get in should be what you get out, assuming there are no problems relating to analog-to-digital conversions, signal-to-noise ratios or quantization issues. The compelling reason not to choose linear is directly related to the data bandwidths required.

A stereo signal sampled at 44.1 kHz, with a word depth of 16-bit, will require a data rate of 1.411 Mbps (plus 10–15 percent overhead and additional for FEC and synchronization algorithms). This data rate bandwidth will cause stress on the IT network passing the data. If the broadcaster adds in additional channels (5.1 or more stereo signals), the word depth deepens to 24-bit and the sampling frequency increases to 96 kHz (or even 192 kHz for the small furry animals that happen to be listening).

It soon becomes apparent that what was a benign solution has now turned into a network nightmare.

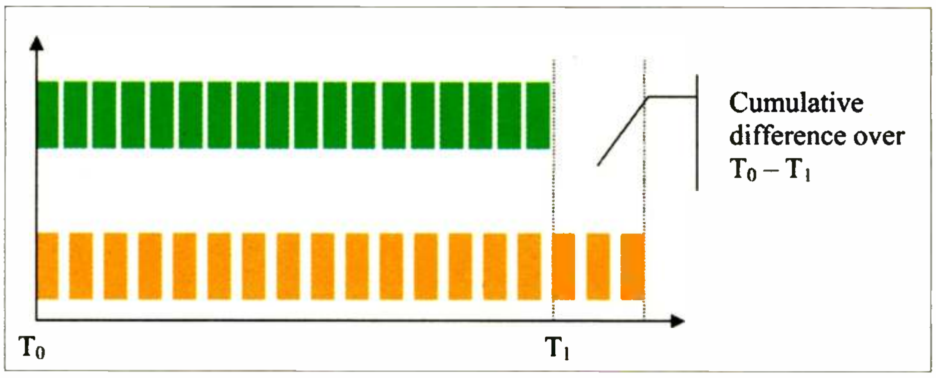

Fig. 4: Clock Skew

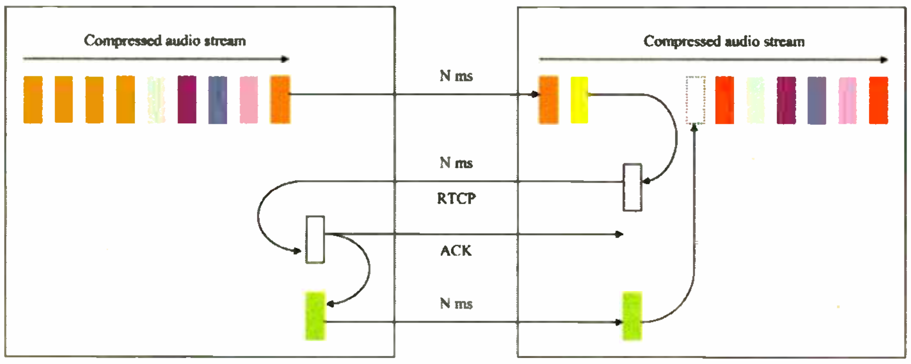

Fig. 5: Retransmission Strategies

Compression

Making the decision to use compression opens up an interesting argument. Two options are available.

First are the perceptual based algorithms using psycho-acoustic based principles that can generally be described as "lossy." Some examples are MPEG Layer II, MPEG Layer III (MP3) and AAC, including the myriad of derivatives. These algorithms are heavily processor-hungry and remove content that is perceived to be irrelevant. As such, they result in content that vaguely resembles the original (especially vague after several passes) and has a long latency, i.e. 50+ milliseconds.

The other option is to use the Enhanced apt-X algorithm, which is based on ADPCM principles and offers a low delay of less than 2 milliseconds. Its acoustic claims have been confirmed by independent listening tests, the most recent of which was with a group of approximately 20 chief engineers from the GWR group (now GCAP after they merged with the Capital Group). This was a double blind listening test with 10 audio samples (different genres, a cappella, spoken voice).

We tested Enhanced apt-X, MPEG and J.41. Enhanced apt-X was shown to be indistinguishable from the original PCM. The Enhanced apt-X algorithm also can offer word depths of 16-, 20- and 24-bit, thus improving the dynamic range to greater than 110 dB.

Working on the assumption that the IP transport stream will naturally introduce a minimum delay of 20+ milliseconds, the latency of the compression algorithm then becomes an imperative when considering the design of a broadcast network. In essence, using a perceptual coder will render the solution unusable for any level of live event that requires off-air monitoring, whereas using Enhanced apt-X offers broadcasters an alternative.

Enhanced apt-X also has an embedded word pattern to aid connection and synchronization. AutoSync aids the ability to quickly synchronize, i.e. in 3 milliseconds on startup or in the event of a dropout. In addition the predictive nature of Enhanced apt-X allows for the masking of lost packets. As such, both features allied together act as a form of FEC without additional overhead.

On a more subjective issue, using multiple passes of a perceptual codec (for example, consider the final emission for HD Radio or DAB) will result in content heavy with artifacts. Ultimately these will cause "listener fatigue," swiftly followed by users tuning to another station that sounds better because it uses less destructive coding algorithms.

Summary

IP as a transport mechanism for broadcasters is here to stay because it allows radio broadcast networks to bundle their audio with data, reduce operational costs and amalgamate IT and audio into a single department. However, these massive and well-defined advantages come with some safety warnings.

Networks should be well managed, packets should be prioritized and correct choices should be made with regard to audio compression. Assuming these boxes are checked, broadcasters will then enjoy the benefits of the transition away from synchronous networks without running into serious problems. ■

MARKETPLACE

Mackie Satellite System Has Pod, Base Station

Mackie says its Satellite FireWire Recording System provides a new approach to digital recording. Its hub is the Satellite Pod, a portable two-channel FireWire interface that incorporates two of the company's Onyx preamps, as well as 24-bit/96 kHz A/D and D/A converters.

Satellite Pod features include dual headphone/control room outputs with individual level controls, two inputs, two outputs and portability.

The Satellite Pod snaps into the system's Satellite Base Station to provide AC power, additional I/O, talkback and monitor switching functions. By plugging the Pod into the Base Station, the system becomes a two-input, six-output FireWire audio interface with features such as a routing matrix, talkback mic, advanced monitoring functions and surround speaker control.

The Satellite System's two inputs can be switched between mic, instrument or balanced line input sources, and its six-channel volume control provides for surround sound mixing. The control room section provides for switching between two separate monitor outputs for multiple monitor speaker setups.

The Satellite System is Mac- and PC-compatible, and works with ASIO and Core Audio-compatible software. It comes bundled with Mackie's Tracktion 2 software for an out-of-the-box recording setup with features including a 64-bit high-definition mix engine, unlimited track count, ReWire and VST support, MIDI controller mapping, external synchronization and integrated support for Mackie Control Universal and C4 control surfaces.

Other highlights include eight inputs for connection of mics, line sources and instruments, two of which are active any time.

The manufacturer's suggested retail price for the Satellite System is $519.99.

For more information, contact Mackie in Washington state at (425) 487-4333 or visit www.mackie.com.

This boring ad can save your butt, make your job easier, and keep the boss happy.

Interested? Good. Now let's get down to the business of keeping your radio station reliably on the air.

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Now let's get down to some solid engineering. No advertising hype, just verifiable facts and figures. Why do PowerClamp TVSS units work so well? How do they work? Here are the answers.

PowerClamp TVSS units have some very significant advantages over virtually any competing product:

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2. **Non-degrading operation.** ***PowerClamp*** performance *does not degrade*. Unlike TVSS units that rely solely on MOVs, PowerClamp's attenuation level remains consistent even after years of service. The ultra-low clamping level results in minimal power dissipation in the suppression components, so there's no degradation. Hundreds of PowerClamp units that were installed in the 1980s are still working today. So will yours.

3. **Guaranteed performance.** ***PowerClamp*** spec sheets quote accurate engineering data. We *guarantee* our clamping levels under real-world conditions. Compare our specs to any competitor (assuming they actually publish their clamping levels) and see for yourself. No smoke-and-mirrors, just performance and results.

For more detailed engineering data and broadcast-user Case Histories, please visit www.henryeng.com. Be sure to view the PowerClamp **Theory Of Operation**.

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by Charles S. Fitch

Factors to Consider for HVAC Design

Consulting an Expert, Knowing the Intended Uses of Your Facility's Space Net More Efficient System

You may not know it but you owe me one. I have spared you much pain and frustration.

The original draft of this article delineated two case studies in heating, ventilation and air conditioning. One was for an elaborate, atypical studio, the other a typical transmitter. The project engaged me for two months 10 years ago.

The former involved the HVAC for a complicated consolidated office and studios in a multistation complex that also originated two regional networks. The detail was excruciating. With great passion I "drilled down" (as the FCC is wont to say) into, around and through the minutiae of this multifaceted climate control system.

I was a few thousand words into the first draft and doing a second read when I put myself to sleep. And I was the one who had designed this system.

When I awoke, it came to me that you don't need to know what I did, specifically, but rather the process that led to an efficient HVAC design solution. What is the critical information checklist? What are the weighing factors that will create a better or best system design when it's time to satisfy your HVAC challenges?

PROFESSIONAL OPINION

One of my favorite quotes is Werner Heisenberg's definition of an expert. In his estimation, an expert is one who knows the most expensive mistakes in his field and how to avoid them.

If your HVAC requirements can't be satisfied with a trip to Home Depot to pick up a few window air-conditioners made in China, it's time to find an expert. I mean a real expert, not the tin knocker who can install a system in a bungalow in a day (and he's proud of it), or the GM's brother-in-law.

You'll need someone who really understands HVAC high-level design, your needs for extreme-demand, no-fail systems and the knowledge of how to translate those needs into the reality of your HVAC installation.

But that expert cannot do this critical task without your input. At a bare minimum you'll need to specify the following.

The space that needs treatment must be described fully, including the total volume and how this is broken down into rooms, and the height, width and depth of each. Window sizes, treatments and orientation of those windows have tremendous bearing on the allotment of capacity to the space, especially in offices. Normally this data is supplied in the architectural drawings, but if you're doing the actual new space construction or retrofitting existing space, you'll have to communicate this data to the expert on your own.

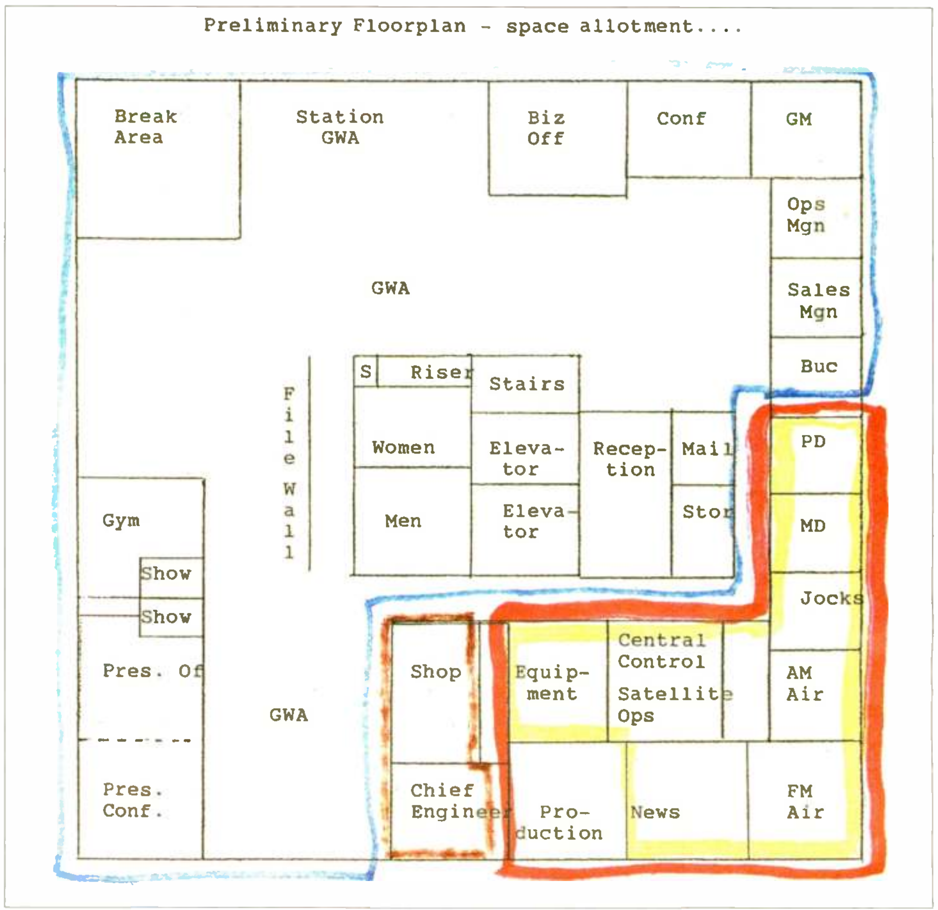

Fig. 1: The author's rough sketch of an HVAC supply system, divided into four layers. The business office is colored blue. Programming is red. Off-hours is colored brown, and emergency is yellow.

Next, describe fully the business tasks to be done in that space and when they will be performed. Occupation, population and time are important factors in the refining stages of the design. For instance, does your company have an open door policy, meaning doors are left open except where confidential activity is taking place? This has substantial impact on the design.

How long will meetings in the conference room(s) typically last? What is the typical meeting size? These factors can have notable effects on the calculations in such specialized places.

Studios, edit suites and production rooms have their own special criteria. The expert needs to know about soundproofing and isolation (room-to-room) requirements. Additionally, what levels of HVAC system noises can be tolerated?

For each studio, the design must take into consideration whether you operate as a combo/solo operation as well as format considerations. For instance, do you have a multi-person "morning zoo" format or a fast-paced "all news/talk" format with a half-dozen producers in the room? Is close-miking the company standard? Does the morning show with its multiple contributors keep the air lock doors open?

In addition to the number and activities of people in these spaces, the caloric waste heat output of equipment, normal and peak, must be provided and the exact location of gear in the room specified. A furniture and personnel office plan, if available, is invaluable for the designer.

The office rhythm and activity relationships must be described fully as well.

Finally, the expert will need to know who or what is important in the space. A quick example: About 25 years ago, after doing what I thought was an outstanding job of HVAC mastery, I was told that the Big Cheese had only three supply vents in his corner office. I protested that the numbers said this was sufficient. I was told that "the Cheese" liked it really cold.

We added two more vents and adjusted the office's VAV box, where heat or air-conditioning is custom introduced to the space. I've never had a faster turnaround on an invoice. "The Cheese" said the system was perfect. The August weather was fine in his corner office of Antarctica.

If your master file server mainframe is the "Big Cheese," make certain the expert knows about it. Frankly, the more this design expert knows about your business, the better the final product will be.

GET RHYTHM

Let's consider examples for the checklist above.

Take a glance at the rough floor plan in Fig.1. On that studio/office/network project, I also drew the first layout of the space for the client. The lease had been signed, and we had the fifth, top floor of a low-rise office building that was nearly 100 by 100 feet square.

You have to start somewhere, and the drawing went out for circulation and discus-

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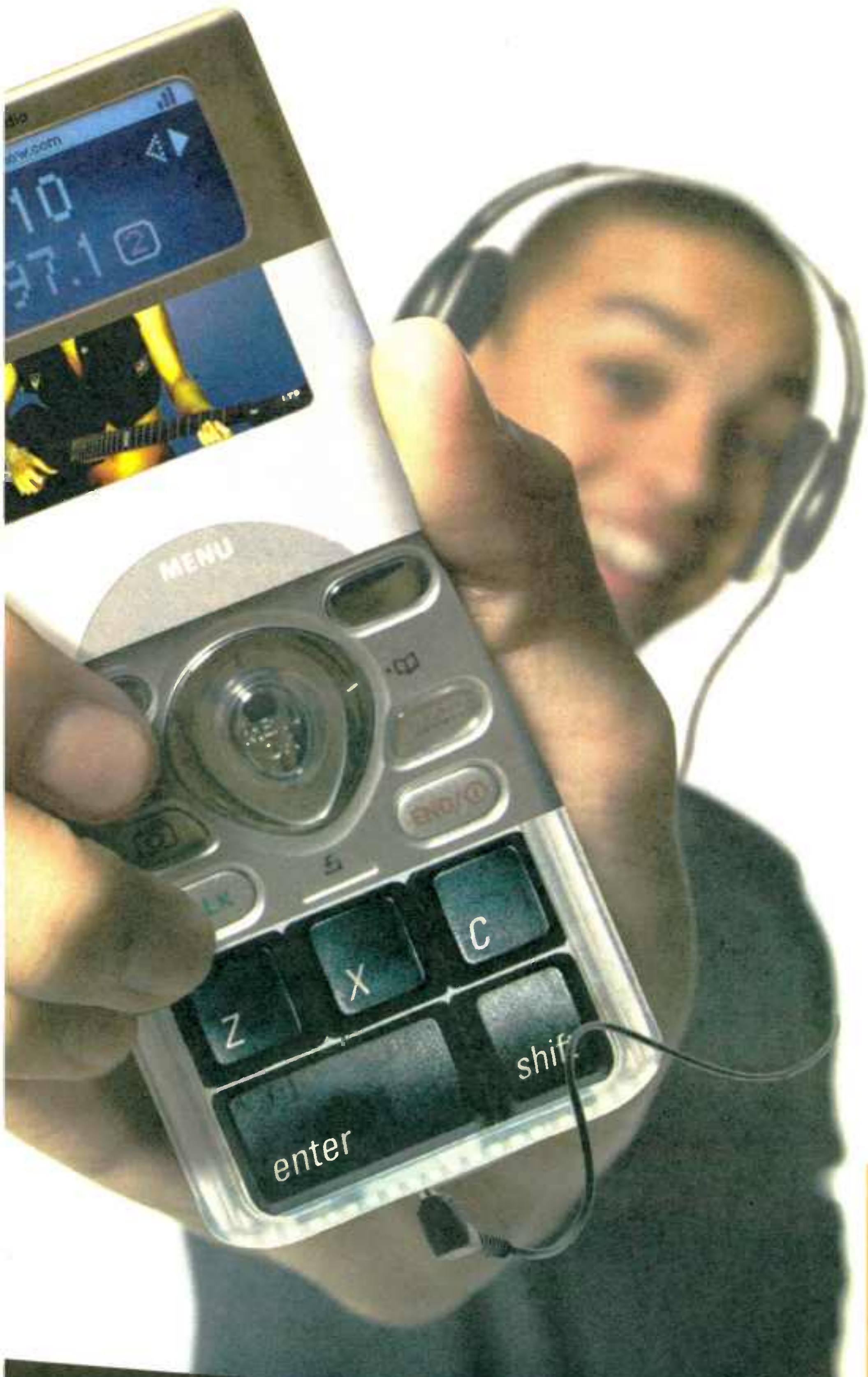
redefining radio



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HVAC

CONTINUED FROM PAGE 24

sion. Before we were done, this primitive review document was built nearly as drawn. The only changes were that the PD and MD offices, as well as the jock's lounge, became studios for the network and additional production; all those people and desks were moved into the General Work Area, or GWA.

Every business is unique in its rhythm and flow. Some appear as chaotic as a mosh pit. Others have a slow, fluid, languid style like the Lambada dance of Brazil.

The corporate culture here was more like the "jitterbug" than the Lambada or mosh. People like human contact and lots of face time. The GWA occupies a large open space interior in the building core. The perimeter offices have glass walls stretching nearly floor-to-ceiling; these provide a sense of openness, which in turn builds team spirit. Large outside windows bring in light; the real world and much of that light progresses into the interior space. This stimulates people to move around.

All of this builds the air-conditioning load in sunny and/or warm weather, and necessitates additional heat capacity in winter from loss off the skin of the windows. But it's worth it. Environmental hygiene factors reflect directly on worker productivity.

This is a happy place to work.

The facility layout should complement that rhythmic style as well as the productive goals of the business. The station complex here is no exception. Once the human activity machinations and personnel concentrations have been established, only then can HVAC design begin.

Broadcasting has special considerations. It typically operates 24/7 and still needs to go when others fail. For that reason, the HVAC supply system was made into four layers (Fig. 1). The business office, normally powered during business hours, is colored blue. Programming that ran 24/7 is red. A little section of "off-hours," showing areas of HVAC that must be powered even in the off-hours, is brown; and emergency — when all else fails — is yellow.

Why the extra complexity? Radio must respond to its community needs and programming requirements so there really are no guarantees for a set operation schedule. For that reason, an "after-hours" setting on the general house HVAC can be accessed via a telephone extension. Touch 999, hit "#" to enable and the time you want it to be disabled automatically and voila, it's like normal hours. Touch "*" to disable the setup if you get done sooner.

So if on a winter Saturday morning the sales staff needs to rehearse an important presentation, the first person to come in advances the settings and puts a noon cancellation on it; within 15 minutes all is comfortable in the conference room. A big bad storm is coming? Press "#" and everyone hunkers down for the duration of the emergency in toasty warmth.

The spatial balance of these areas has a rhythm so different from the rest of the offices that they require their own dedicated HVAC systems.

UP ON THE ROOF

On the roof are packaged units directly ducted to the programming areas, such as the air studios, the production suites and the terminal room, the essential heart of these stations. Because of the high caloric output of the technical gear, we ordered only the smallest heat elements available for these units. These can be used for humidity control as well.

To support both the station's continued operation and to carry these near-mandatory HVAC systems, a natural-gas-powered generator, fueled by the same utility gas supply system as the house heat, is located on the roof downwind from the air inputs of the HVAC systems.

These technical spaces were arranged carefully to be on the outside wall of the building such that small AC units are mounted in the walls as the ultimate backup (there's method to our madness). If the rooftop units fail, cool air from these units can be circulated directly into and through the critical spaces.

Although the chief engineer's office and shop space are on the house system, wall-mounted units (on the generator as well) were included for these locations to allow the technical staff the greatest flexibility in emergencies and during off-hours maintenance work. This "on-demand" heat or cool allows the most casual occupancy of these spaces.

See, that's about all the detail you really wanted. You didn't need three pages of duct design, soundproofing instructions and a description of the reheat controls, did you? I mean no aspersions to detail, because it's in the details that a successful system is born. But some details are more important than others.

Capacity margin is one of those details.

FEAR FACTOR

In 2006, two considerations steer design quality more than others: fear and competition.

Fear in this case means a justifiable concern about litigation, where the customer decides that they have not received an appropriate or adequate design. Most practitioners have taken to "defensive engineering," not much different from medical doctors practicing defensive medicine. The numbers — the absolute value defense — rule.

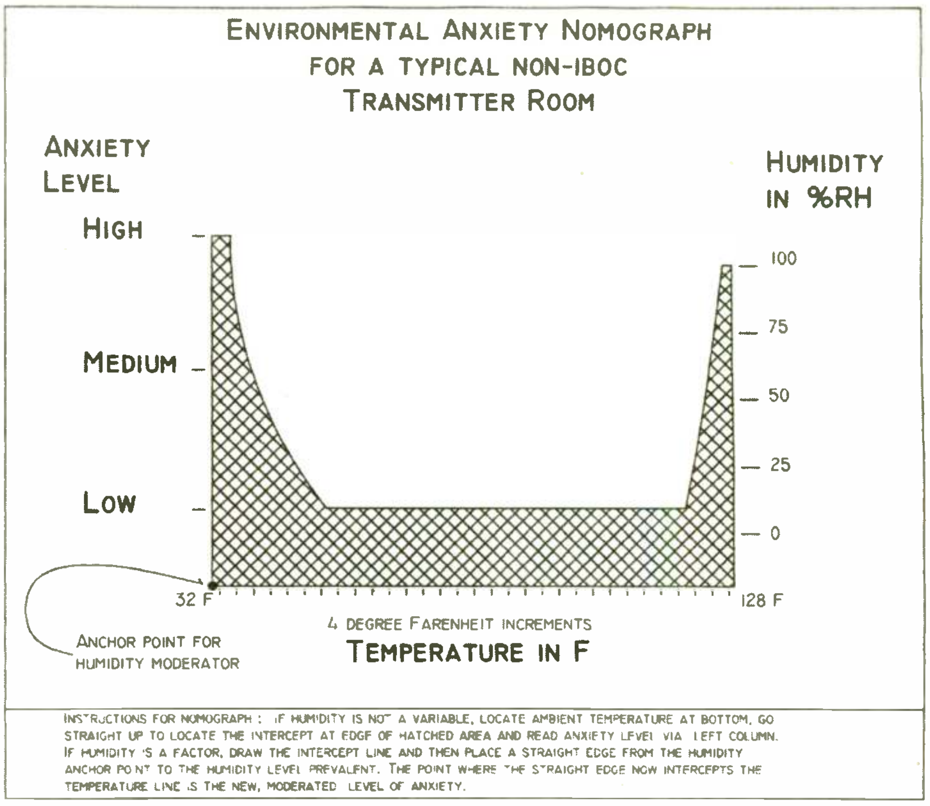

Fig. 2: Nomograph for a New England Station

Severe competition for work also has caused a crisis in specifications — terms don't always mean the same thing to everyone who is bidding — and a phenomenon in which the contractor redesigns the system after the project is awarded, or substitutes equipment of lesser quality under the umbrella of "functional equivalents."

For these reasons, "capacity margin" is one of those items that is shaved to a minimum or doesn't exist in most designs, no matter which euphemisms are employed. Everything the customer is expected to do is used as a reason to explain why a system does not work as expected. From the moment it's turned on, every system suffers from the following deleterious circumstances: hygiene, maintenance and deterioration.

Hygiene is any factor that is caused by nature or biology. Pine pollen clogging condenser coils and mold clogging evaporator coils are good examples.

Maintenance includes routine items such as air filter replacement or cleaning, belt tightening on blowers and keeping vents both supply and return clear.

Deterioration encompasses such hidden items as wear on the seals in compressors and motor bearings.

System diversity and capacity margin are your only insurance that your station will not have an HVAC catastrophe when you encounter an extreme situation. A margin of 25 percent for heating and cooling should be considered minimum excess. If incorporated into the design as stages, it actually will yield an operating economy, as each stage will be operated up its efficiency curve. Some locations (below the Mason-Dixon line for AC) will necessitate as much as 40 percent excess.

Make certain these margins are in the design and that they are actually installed.

As an example of getting what you paid for, I discovered while inspecting a large AC unit recently that the electrical supply circuit was smaller than the nameplate rating, which is the manufacturer's mandate of the minimum circuit ampacity and the maximum fuse or circuit breaker size that will protect the unit.

The verbiage usually is written such that a single choice is all that's given the electricians. In this case it was a 480V delta (three-wire) 70-amp circuit. They installed a 60-amp service. When queried, the electricians told us that was sufficient. We knew exactly why they did this. The larger circuit breaker, larger conductors, larger conduit and larger disconnect box cost approximately $300 more to provide. Competition had caused them to bid low, and this cost penalty went directly against their profit. The electrical inspector would not approve the job until they came back and replaced the circuit with a 70-amp.

It's uncertain whether they made any money on this job, as they had to return, take out what was there and install what was correct.

Out at the transmitter all the above factors are in place except that the goal (more thoroughly discussed in our two previous articles) is not comfort but guaranteeing reliability and limiting equipment deterioration. The designer in this case needs not only all the data previously noted, but also the temperature extremes and the humidity limits the equipment can handle.

As with a convoy at sea in WWII, where speed was determined by the slowest ship, the limits are set by the most vulnerable piece of gear in the transmitter building. In the new universe of HD Radio, an embedded computer chip in an importer with a high-end ambient limit of 75 degrees Fahrenheit might set that edge-of-the-design goal. Sometimes it's more cost-effective to isolate and separately treat critical equipment, such as putting all the terminal gear in an air-conditioned rack or in a separate air-conditioned room.

A traditional non-HD station could be more tolerant. Look at Fig. 2, a nomograph for a station here in my part of the world, New England.

In conclusion, other than the transmitter and antenna, there is no other system from which more is demanded than HVAC. Your design must provide flexibility, economy of operation and substantial backup to backup.

A well-designed custom system that matches your needs is an investment. It is money well spent.

Charles Fitch, P.E., is a frequent contributor to Radio World. ■

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Satellite in Trouble as HD Grows

HD Radio Sales May Be Slow, But XM and Sirius Stocks Decline and Subscriptions Plateau

Guy Wire is the pseudonym for a veteran radio broadcast engineer.

As the hot summer months course through the 2006 calendar, we are beginning to see a number of important evolving events and clues emerge that preview how the competing forces of satellite radio and HD are likely to fare in the future.

Satellite radio recently has passed the 11 million mark in total subscribers, and may announce more around the time this issue reaches you, as both XM and Sirius continue to spin their growth stories moving towards profitability "in the near future." Not much has altered the business plans that the companies have fashioned to gain a foothold in the radio landscape: increase content offerings with big brand names in the lineup to attract and sign up enough subscribers to pay expenses and, eventually, make a profit.

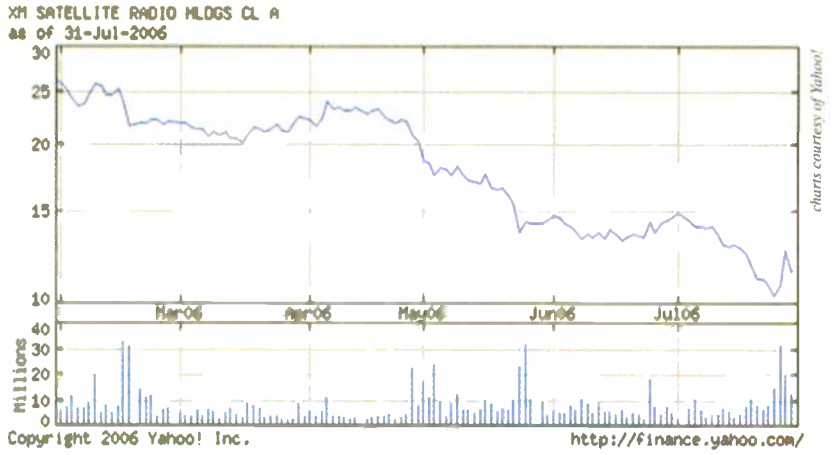
But some of these additions, like Major League Baseball, the NHL, the NBA, NASCAR, Howard Stern, Martha Stewart and Oprah, have been obtained at ridiculous prices and produced massive debt.

For the most part, investors have given satellite a long honeymoon. But for the first time in its five years on the air, both services are seeing subscriber growth rates slow and begin to level off. This is exactly what investors have feared the most: the lofty projections of the number of anticipated XM and Sirius subscription sales may be more smoke and mirrors than real.

BOGGED DOWN

Wall Street has hammered both companies' stock prices downward over the past year. Without sustained subscriber growth, neither will have a prayer of turning the corner of profitability.

Stern has had about eight months to lure as much of his old terrestrial audience as possible over to his new home. He had about 12 million daily listeners before moving, but his Sirius total appears to be slowing down at about 1.6 million subscribers.



charts courtesy of Yahoo!

Stock prices tell the story.

Analysts have reported that Sirius would need at least 3 million Stern subscribers to break even. If it doesn't happen during the first year, it's probably not going to happen.

The big marketing blitz is over as most Stern fans have already decided to pay the money and follow him or stay with other free alternatives on terrestrial. That's not good news for a company that pinned much of its expected growth on one show.

Add to the mix the recent move by Opie & Anthony coming back to CBS Radio to shore up the loss of Stern's syndication, a striking turn of events for a company that had fired them only two years ago over the sex-in-church caper.

Opie & Anthony had been toiling away on XM out of earshot from the vast majority of radio listeners. In only a few Arbitron surveys, they've already delivered impressive gains for many markets that were feeling the pinch of losing Stern, such as Philly, New York and Boston.

Stern can't be very happy about Opie & Anthony and his former network dancing on his terrestrial grave, carrying his old party forward.

SURVIVAL STRATEGIES, REALITIES

Both Stern and his boss Mel Karmazin at Sirius have got to be thinking how they could re-leverage Howard back into terrestrial radio if indeed his new subscription rate slows and stops growing.

Radio has always been a house full of strange bedfellows. Don't be surprised to see Stern show up on terrestrial again. That would surely not make those 1.6 million fans who pay extra to hear him on Sirius very happy.

The only other options to stop the bleeding are to raise the subscription rates and sell more commercials on Stern along with other Sirius channel offerings. Too many ads are a headache that the majority of folks who pay to listen to radio want very much to avoid, and such a strategy easily could trigger mass cancellations.

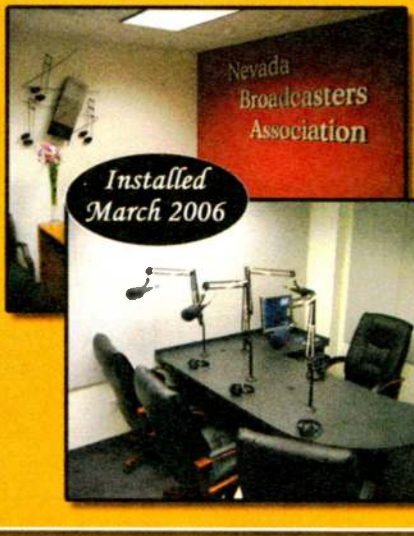
Satellite certainly has established a solid fan base and serves a valuable function in the U.S. radio marketplace. But the hill that both satellite radio services are climbing toward profitability seems to be getting steeper every day. Aside from slowing subscription rates, the RIAA is proposing big increases to both for music royalty fees, resulting in XM pursuing an expensive lawsuit over that issue.

XM is now facing a new round of FCC problems, with thousands of radio converters that cause too much FM band interference. Add to that allegations that Sirius may have intentionally published inaccurate specs on its converters showing they met the interference limits when in fact they did not.

If that wasn't enough, a key XM board member resigned earlier this year citing internal mismanagement and a possible looming financial crisis at the company.

The satellite service is obviously moving

SEE GUY, PAGE 30



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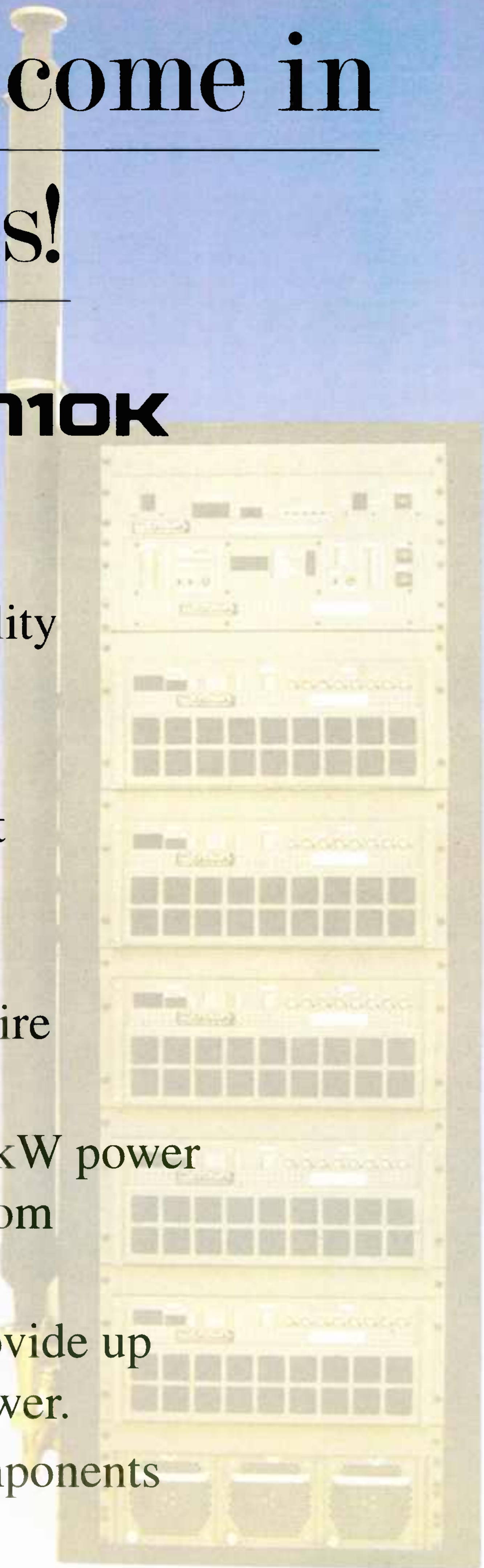

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Guy

CONTINUED FROM PAGE 28

into a new phase of its evolution. It's been playing a game of beat-the-clock from the beginning. Time just might be starting to run out.

As with any other high-tech venture that over-promises and under-delivers, investors eventually run out of patience and head for the exits. If current management teams cannot find a way to scale back expenses and increase revenue to keep the businesses growing, heads will roll. Changes at the top including a newly appointed COO were announced at XM in late July.

Mel Karmazin has been musing publicly about the prospects of Sirius and XM merging into one company in the future. Sirius has launched better marketing campaigns and has been adding new subscribers at a faster clip than XM since Stern came on board in January.

Whom do you suppose would be very interested in buying the Ford and/or GM satellite holdings, should they go on the block at attractive prices? Why, terrestrial broadcasters, of course!

Karmazin certainly would prefer to acquire control of any new merged company. But XM is the much larger service of the two, and before stumbling a bit lately it seemed to have a better shot at eventually becoming profitable, albeit a long shot.

Karmazin probably wouldn't be talking merger unless he felt in his gut there wasn't room for both to become profitable and survive. Ostensibly, such a consolidation would allow one entity to be able to better manage their collective assets and reduce liabilities to allow an independent satellite service the rights of survival. But FCC rules for the service were written to establish two separate companies to ensure a competitive environment. Changing those rules could be problematic.

HITTING BOTTOM

As year after year of red ink keeps flowing off their books, stock prices of XM and Sirius could easily plummet further. Eventually the liabilities could outweigh even the perceived value of the assets and the major stockholders would demand action. Either the controlling interests of each company would negotiate amongst themselves to restructure the assets and the business plan into something that would be acceptable to the owners who remain. Or, a Chapter 11 reorganization bankruptcy would proceed.

The major stockholders of XM include General Motors and Clear Channel Radio. Ford Motor Co. holds a large stake in Sirius. It's no secret that these U.S. carmakers are in financial distress. It's not unlikely that either could choose to spin off those interests if management decides their satellite radio holdings no longer hold enough potential value, and instead represent more of a liability adding to their already staggering company debt.

Such a decision would be akin to colleges and universities that find themselves beleaguered in debt and decide to sell their valuable NCE station licenses. Many such stations did not contribute income but instead were mostly a financial burden, even if they did provide a public service and PR function for the school. Somebody else with deeper pockets came along with a business plan and vision that could better harness the value and the earning power of the channel.

IN THE WINGS

A similar scenario could play out with satellite radio. Whom do you suppose would be very interested in buying the Ford and/or GM satellite holdings, should they go on the block at attractive prices? Why, terrestrial broadcasters, of course!

They are the wellspring for most of the content and talent that subscribers have always heard on satellite. They invented the art form and the substance of good radio. As terrestrial radio diversifies its own services with Internet streaming and HD multicasting, satellite would just become another component part of the burgeoning stable of products.

Most of the leading American terrestrial radio companies are churning out impressive cash flows and ROIs. They are mature businesses with solid balance sheets, manageable debt and long track records of financial success. Assuming FCC rules can accommodate it, who better than they to develop and manage properly the satellite offerings as part of the total radio package?

Before all you liberal anti-consolidation zealots scream bloody murder, fearing the airwaves would be controlled by even fewer players in such a development, take a deep breath, step back from the fray and consider this: Consolidation has allowed many of the more marginal terrestrial facilities to "stay alive" and serve niche audiences, including ethnic and minority group interests.

REWRITING THE PLAN

Competing effectively year after year in either the commercial or public broadcast arena takes money and expertise guided by a viable and realistic business plan. Group owners with more extensive resources than stand-alone operations are almost always in a better position to take risks and properly support format changes and start-ups that may lose money for some time before they develop into self-sufficient sustaining businesses on their own.

These companies do not harbor or promote some monolithic right-wing agenda, nor do they decide what's good programming without extensively researching and polling the needs and concerns of potential audiences. If a new format can attract significant listenership and have staying power, you will generally find it somewhere on the dial.

Should the satellite services be restructured and terrestrial radio become the controlling interests in their ongoing operations, it is quite likely there would be a consortium of companies stepping up to own a piece of the action, rather than one company attempting to acquire and control all of either sat service independently.

Public radio should be part of this new mix as well. More voices could potentially be involved in the decision-making of satellite programming and operations than we have now. The downside risks would be mitigated and spread out across multiple owners.

A LONG-TERM INVESTMENT

The HD rollout continues at a steady pace with more companies stepping up to equip their second-tier markets with HD and HD2 capability. Many major markets now feature virtually all of their major FM stations with HD. AM-HD adoption will remain slow and scattered until the rules allow full-time HD operations and the attendant fallout of interference is better known and eventually resolved.

It's becoming clear that the companies that invest in HD and install the gear and the programming to support it are in this for the long haul. From what we've seen, their owners and operators understand that commitment, perseverance and patience will be needed to promote the new services and allow HD receiver penetration to grow towards critical mass.

We won't see much movement in that direction until major car companies include HD and multimode radios as OEM equipment in new model cars. All indications point to 2008 for that watershed process to get rolling.

HD2 will most certainly bring many more format choices to the dial, giving listeners new options they could only find on satellite or manufacture themselves via CD and iPod collections. The real value of those additional channels will not be realized for quite awhile, however.

While many may start out as fully automated voice-tracked jukeboxes, programmers will dress them up to be worthy competitors to both satellite and their own main channel stations over time. Eventually many should emerge as full-fledged stations in their own right, competing head-to-head with their main-channel hosts.

HD naysayers are still predicting that if HD receiver sales don't take off quickly, the service could easily falter and meet a relatively quick demise, similar to AM stereo. That's like comparing the rollout of FM stereo to that of FM quad. Music on FM already sounded good enough in stereo to most listeners while quad was deemed a gimmick for aficionados, little known to mass consumers. Like AM stereo, the industry really didn't need FM quad, it so it was largely ignored.

FM stereo, on the other hand, did make a real difference, although not an earth-shaking one at the time for the average listener. Like HD, it was an important technological innovation the entire industry embraced and supported. Stations installed stereo encoders, radio manufacturers integrated stereo reception into receivers at all levels and consumers bought them whether or not they wanted the new feature or were even aware of it.

REMEMBER FM STEREO

From the time FM stereo standards were adopted in 1961, it took at least 10 years for the new mode to take hold in the marketplace and another 10 years before FM stereo became the dominant choice for consumers of radio entertainment.

The same pattern is likely to be charted by HD Radio. It's just going to take time to make it to critical mass. Along the way, the technology will no doubt continue to improve and refine its present offerings. New ones not yet even dreamed about will certainly be added. HD is much more than just your daddy's FM stereo.

But the conversion should not take as long this time around with the advantages of digital being so much more flexible and scalable. It can easily accommodate new payloads and features in the coded bit stream that were utterly unthinkable in the analog era. Both the transmission and reception ends of the process can be updated relatively quickly and efficiently.

There is no other transport option that makes better sense for the industry going forward. There is simply no turning back now.

RWEE welcomes other points of view to rwee@imaspub.com. ■

MARKETPLACE

AudioScience Adds to ASI6600 Series

AudioScience has expanded its ASI6600 line of broadcast PCI Express sound cards to include models ASI6620, -6622 and -6640.

The ASI6620 has six stereo play streams mixed to two balanced stereo outputs, and four stereo streams of record from two balanced stereo inputs.

The ASI6622 builds on the ASI6620, but adds two AES/EBU inputs and outputs with a dedicated AES/EBU sync input and word clock input.

The ASI6640 has 12 play streams mixed to four balanced stereo analog outputs, and eight stereo record streams from four balanced stereo analog inputs.

The ASI6640

The company says the ASI6600 series builds on the ASI6000 line, but adds a faster DSP, short-length PCI format, +24 dBu analog levels, 96 kHz sample rates and SSX multichannel support. Features of the ASI6000 line also are present, and include MRX multirate mixing, MPEG Layer 2 and 3 encoding and decoding, TSX time scaling and SoundGuard transient voltage protection on I/O.

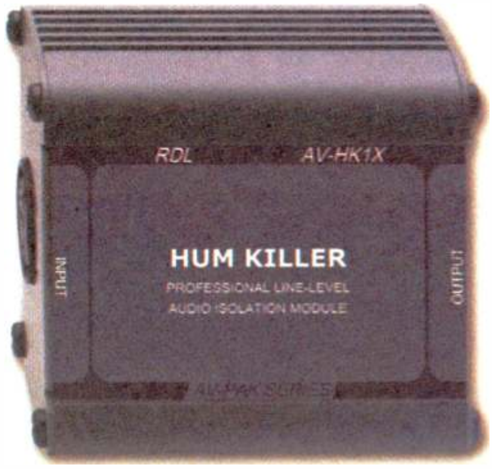
For more information, contact AudioScience in Delaware at (302) 324-5333 or visit www.audioscience.com.

AV-PAK Has Audio Combiner/Divider, Isolation Modules

Radio Design Labs debuted the AV-HK1X "Hum Killer" audio isolation module, part of the company's AV-PAK Series. The company says it isolates mono equipment from sound system inputs to reduce or eliminate "ground loop" hum; XLR jacks with gold-plated contacts ease input and output connection.

An audio transformer provides galvanic isolation between the input and output. The AV-HK1X breaks the "ground loop" connection that can produce hum in a sound system. The input connector shield provides a radio frequency ground return, which the company says preserves system immunity to radio interference.

The AV-DC4 is part of the AV-PAK Series, as well. It is a mono transformer-coupled audio divider/combiner module for use with balanced, low- or high-impedance audio inputs and outputs. It features four identical channels, each of which may be used as either an input or as an output. Two XLR jacks (one male, one female) are provided on each channel.



RDL 'Hum Killer' Module

RDL also introduced the RU-ADL2, a DSP-based dual-output delay for an analog studio source. Features include 96 kHz sampling and Sure-Lok circuitry and coding, which the company says supervises audio and data signals for accuracy and stability. The RU-ADL2 is suitable for use as a standalone delay, or its input may be connected in parallel with multiple RU-ADL2 modules to provide additional delayed outputs.

Also new, the RU-SH1 stereo headphone amplifier mounts in the company's Rack-Up Series rack-mount adapter or chassis. RDL says it is used in applications requiring headphones of any impedance to be driven from consumer or professional audio sources.

For more information, contact Radio Design Labs in Arizona at (800) 281-2683 or visit www.rdl-net.com.

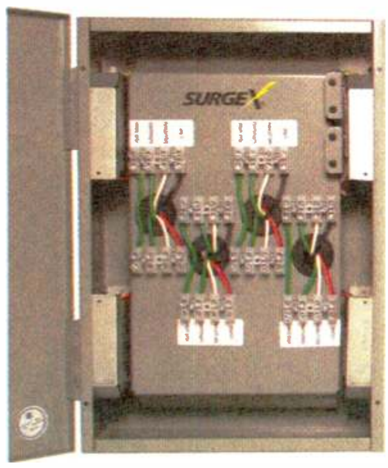
SurgeX Offers Higher-Ampacity NEMA Unit

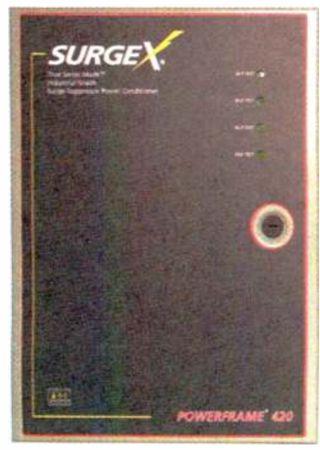
SurgeX added Powerframe 420 Advanced Series Mode AC surge eliminator power conditioner to its product line. The 80-amp load center comes in a 16 x 12 x 4 inch NEMA enclosure. The company says it allows for protection of four 20-amp branch circuits, and features Impedance Tolerant EMI/RFI filtering, in a compact design.

Series Mode technology is an alternative to conventional MOV circuitry, and stops multiple surges of up to 6,000 volts and does not produce ground contamination.

Surgex says it created the Powerframe 420 in response to consultants' requests for a higher-ampacity NEMA unit. It carries a 10-year warranty, as well as an A-1-1 rating for protection from spikes, surges and inductive transients.

For more information, contact SurgeX in Pennsylvania at (215) 766-1240 or visit www.surgex.com.





by Cris Alexander

Buffalo Charging Your Site? Call Your CE

Today's Engineers Must Be Comfortable With HD, IT And Fiber Optics — and Ready for Crazy Emergencies

The author is director of engineering for Crawford Broadcasting Company in Denver.

When I first started snooping around the local radio station many years ago, I became fascinated by the chief engineer. He was a frumpy, solitary fellow who was inclined to communicate with grunts and gestures as much as spoken words. But he was a master at his craft.

Everything was in its place in his well-organized shop. The transmitter room was as spotless as the reactor room on a nuclear submarine, and a peek at the "Christmas tree" wiring blocks in the equipment racks showed the care with which they had been connected.

His workday was varied; no two were alike. Some days found him wiring up patch panels in the shop. Other times he would work on the automation system — once a hulking giant with cart carousels and reel tape machines.

Maybe the best times were when he worked an all-nighter, doing something or other to the transmitter, the phasor or in the tuning houses. He worked on air conditioners, mowed the grass around the towers, changed the oil in the generator and occasionally unstopped a toilet. He designed and built devices to meet specific needs and, as such, was an engineer in the truest sense of the word. He was a Jack-of-All-Trades and master of all.

He was always busy, never still, never bored. I cannot remember ever hearing a complaint from his lips. I wanted to be like him.

A lot has changed in the 30-some-odd years since I started in radio. Our technology has gone from tubes to transistors to ICs to microprocessors and DSP. Long gone are the "Christmas trees" for wiring consoles and patch panels. Rotary faders and VU meters are by and large in the past. Few transmitter sites still offer the red glow of modulator and PA tubes through a smoky window on the front of the transmitter.

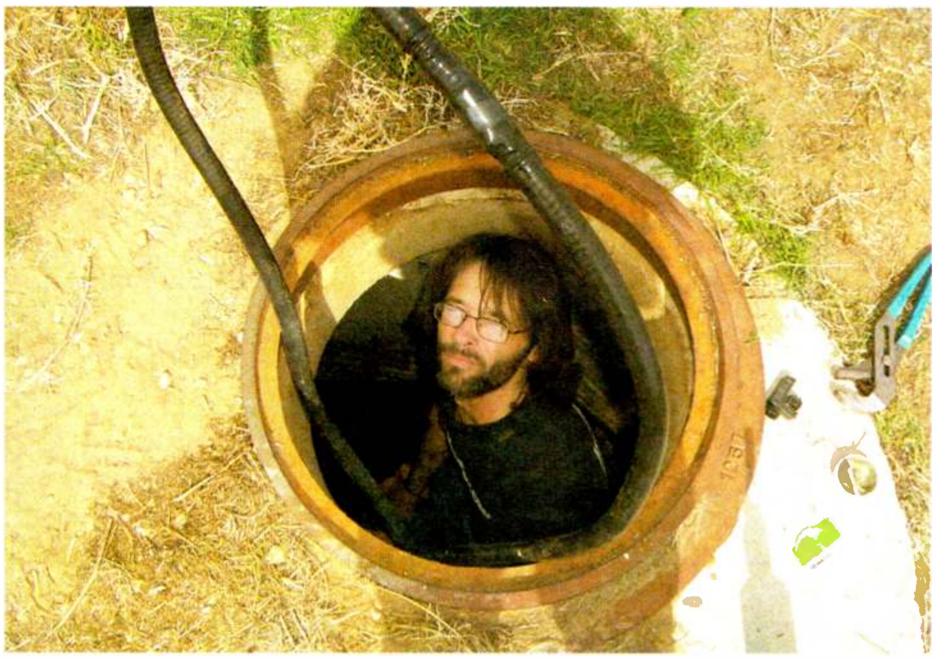
Along with all the technological changes came changes in the job description of the radio engineer. Perhaps "technology manager" would be a better job title these days, as little in the way of real "engineering" takes place at the station level anymore. We live in a plug-and-play world where we can purchase a piece of equipment to fit just about any need.

It's true that the radio engineer has to pull it all together in a coherent, functional way, but not in the same way as did engineers of old, who had to conceptualize, design, build, install and maintain.

DEFINE 'TYPICAL'

So how would you describe a day in the life of a radio engineer in 2006? If asked, what would you give as a list of a typical day's duties?

It's been a long time since I have been in the trenches of a local station, doing battle with studio equipment, processors, STL systems and transmitters; but I continue to live the engineer's life vicariously through the many talented and capable engineers who work for our company. They keep me informed of their daily activities and enlist my help in thinking through specific problems and issues. I like to think, then, that I remain in touch with the workaday engineering world.



CBC-Denver's Keith Peterson works in a manhole repairing a burned-out transmission line.

Is there such a thing as a "typical" day for a radio engineer? If there is, it's sure not what it used to be. Radio engineering today is as much about IP addresses as it is about antennas. It's as much about fiber optic cable and CAT-5 wire as it is about transmission lines. It's as much about the high-tech IT world as it is about the low-tech wildlife world. It's probably more about property management than show business. Radio engineering is varied, far-ranging and, best of all, fun.

With this issue of RWEE, we begin a new column that is about radio engineering in today's world. In these pages we will deal with the real-world issues that you are no doubt facing. My sources will be the many engineers within Crawford Broadcasting Company and you. We will explore problems and solutions. We will deal with specific questions and general ones. I hope you will come away with some tidbit of knowledge or insight that you can use to do a better job.

CONVERSION CONSIDERATIONS

From time to time, those of us who do our engineering at the corporate level actually get to do something that resembles "real engineering," something for which we can use our technical skills more than our budget/spreadsheet skills. While I can't speak for my colleagues at other groups, these are the projects I live for and I suspect that it's much the same for them.

In recent weeks, I have been working with the management and chief engineer of an FM station in Pennsylvania that is just about ready to make the move to HD Radio. The station has a 20-year-old transmitter that is in good condition, although it is admittedly nearing the end of its useful life as a main transmitter.

For this particular station, a Class B with a TPO of about 8.5 kW, just about all the options are on the table — high-level combining, common-amplification and separate antenna. In working with the crew at this particular station, I have had to repeat what I did for all of Crawford's FM stations several years ago: perform a detailed cost analysis of each option.

If you have sat in on some of the NAB sessions on HD Radio conversion, you have no doubt come away with more questions than answers. Each presenter brings his own experiences and biases to the table, and while there is tremendous empirical value in such experiences, this doesn't tell the whole story.

Radio engineering today is as much about IP addresses as it is about antennas. It's as much about fiber optic cable and CAT-5 wire as it is about transmission lines.

In guiding our friends in Pennsylvania through the process, I suggested the use of a spreadsheet. The capital costs of each option factor in to the spreadsheet, including equipment: tower structural analysis and possible upgrades; antenna; transmission line; transmitter building expansion; annual operating costs factored out over the life of the equipment; and any/all other costs associated with the conversion.

Sum the capital costs into one cell, sum the operating costs into another, and then sum those two costs into a total lifetime cost cell. Do this for each of the possible configurations and compare the results. They may surprise you, and they will differ widely from situation to situation.

For example, in stations with TPOs of less than 7 kW or so, common amplification (i.e., low-level combining) may well be the best way to go. The capital cost of a linearized transmitter capable of producing the required HD+FM power level may well be lower than that of a lower-power, HD-only transmitter plus a non-linearized analog transmitter plus the 10 dB injector and reject load.

Operating costs of the single-transmitter common amplification scheme over a 15-year period may be close enough to that of the high-level combined operation to make this much simpler conversion scheme cost effective.

Go up a little bit in TPO, however, and the story may be completely different. You may find that the high-level scheme will save tens of thousands of dollars over the life of the equipment. This is likely to be even more so if the existing analog transmitter is relatively new, say 10 years old or less, with a lot of life left in it. If there is no compelling reason to replace the analog rig outside of the HD conversion, it may be much more economical to keep it and use it in a high-level combined scheme.

The bottom line here is that the bottom line determines the best course of action in each case. The variables are many, and the equation must be solved for each station's situation. If you are contemplating an HD Radio conversion, particularly for an FM facility where you have a lot of options don't neglect to consider all the costs.

BLASTED LINE

One of our market chief engineers has been doing battle in the trenches (quite literally) with a transmission line that has burned out six times since the facility went on the air a few years ago.

When a directional antenna system is designed, if money is a factor — and isn't it always? — the phasing and coupling system must be designed to fit the need with a minimum of expense. Capacitor, coil and other component ratings are chosen to fit the application with a reasonable safety margin. Transmission lines are normally selected to handle the nominal power distribution with a safety margin, derated for modulation and VSWR.

For example, the line feeding a tower that has a nominal power of 5 kW should

SEE BUFFALO, PAGE 35

Products & Services SHOWCASE

Buffalo

CONTINUED FROM PAGE 32

is rated to handle at least 1.7 times that power with 125 percent positive modulation and a 2:1 VSWR. This conservative rating will ensure in most cases that the line won't burn out during an out-of-balance condition in the system. In most cases.

In one of our 50 kW operations, we have had a number of lightning-induced burnouts in one particular transmission line. The line, a piece of 7/8-inch air dielectric line, nominally handles 5 kW or so. It is capable of handling 7.5 kW or so, derated for modulation and VSWR, so this piece of line should be fine for the application. So why does it burn out when lightning zaps the array?

The problem with 50 kW arrays, particularly those with 10 percent or less power in some towers, is that a lightning strike can produce a momentary imbalance in the power distribution of the array. If the high-power element is zapped, that tower will present a short circuit to ground while inside the line. Because the shunt path through the now arcing and shorted low-power line represents only about 10 percent of the total power in the system, it does not produce enough reflected power at the transmitter to trip the fault circuits so the transmitter stays on and the arc is sustained for minutes or hours.

So what can you do in such a situation? I've been scratching my head on that one for a long time.

The first thing we tried was placing a ball gap on either end of the transmission line, right at the connection point, cranking it down to the point where it almost arcs on modulation peaks. That should do it, right? Evidently not, as we continue to get occasional burnouts.

When the high-power tower arc occurs, the driving point impedance at the low-power tower changes considerably, as you would expect it to. As a result, a standing wave forms on the line such that the voltage is very low at the end of the line but quite high some distance down the line. The arc occurs at the high-voltage point and not at the ball gap. We could increase

An airtight temporary splice is made using copper strap and tubing to hold things together until a permanent splice can be obtained from the manufacturer.

the air in the ball gap is ionized and conducting. Until the VSWR or fault current protection in the transmitter kicks in, all that power is going to go somewhere, and in this case, a good portion of it goes into that piece of 7/8-inch line — enough to produce an arc within the line.

The pathology of the damage is this: Lightning strikes the high-power element (27 kW) and produces an arc and short circuit to ground at the ATU output. Before the protection circuits can shut the transmitter off and extinguish the arc, excess power is fed to the low-power transmission line and produces an arc and carbon path inside the line. The transmitter protective circuits mute the RF excitation and the arc at the high-power tower is extinguished.

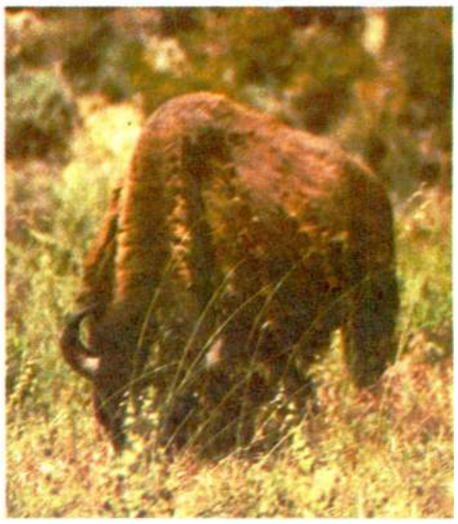
The transmitter comes back on at full power without the high-power tower short, but now the low-power transmission line with its carbon path cannot sustain its rated power, so the arc again develops the sensitivity of the VSWR protection, but then we would get nuisance trips in normal operation.

The obvious permanent solution is one that I've been putting off for some time: replacing the 7/8-inch line with 1-5/8-inch line. This is easier said than done, as the line is long and buried, and it passes under an irrigation canal. Besides the big expense of replacement line (driven up by the cost of copper), installation will blow the budget. But I know that's where we're headed; that is, unless someone has a better idea.

MAD BUFFALO

Here's one you're not going to believe. Our Los Angeles chief engineer has been dealing with a mad buffalo. Yes, I'm talking about those big, ugly creatures you saw the Indians chasing around the plains in "Dances With Wolves."

The KBRT(AM) 740 transmitter site is located on Santa Catalina Island, the "Island of Romance" of song. I tend to think of Catalina in different terms. Back in the 1920s, some movie producer barged a herd of buffalo over to the island to make a movie. At the end of the shoot, they just left the buffalo on the island. The herd has done well over the last 80+ years and is



The Wild Beast of Santa Catalina Island

now about 450 in number. You can get a buffalo burger at the Buffalo Nickel Restaurant next to the heliport.

At the KBRT transmitter site, we have dealt with buffalo since the site has been on the island. Normally, the buffalo behave a lot like cows, relatively docile creatures looking for something green to eat. Over the years, we've had to run them out of the antenna field periodically, then find and mend the break in the fence where they got in. If we don't move them out right away, they tend to damage the tuning houses and ground system and rub themselves on the guy wires and anchors.

Of late, however, we have had a bull that is aggressive, deliberately breaking through the fence, charging our engineer Bill and his dog and smashing things at the site. On one occasion, Bill had to use the front-end loader bucket on our tractor to persuade him to leave.

During a recent middle-of-the-night episode, the crazed beast did a good bit of damage at the site, finally being run off after our engineer's son hosed him down with a paintball gun. We told the people who manage the wildlife on the island that they can tell which buffalo is the aggressive one by the paint splatters all over his hide.

Is dealing with an aggressive, crazed buffalo normally part of a typical radio engineer's job description? I sort of doubt it, but it is part of Bill's. And from time to time, playing cowboy from the seat of a tractor is part of a day in the life of at least one radio engineer. No one told me I could expect that when I got into this business.

In the broadcast engineering trade, our day's work can include almost anything. We never know what to expect. In this company, our engineers must adhere to the company dress code and wear slacks and sport shirts, but many of our engineers keep a "go bag" handy with a pair of old jeans, a tee-shirt and sneakers inside. They may be at the keyboard of a computer writing code in the morning and at the controls of a backhoe digging up a bad sample line in the afternoon. They could be crimping connectors onto network cables and have to drop that to deal with a snake in the transmitter.

Radio engineers have to be ready for almost anything, and while this presents certain challenges, it's what makes our jobs interesting and fun. Most of us wouldn't have it any other way.

In future columns, we'll look at other "day in the life" topics, stuff that you and your fellow engineers are dealing with every day, the usual and the unusual. In doing so, we hope that you will be enlightened, educated and entertained. And we hope to hear from you from time to time.

Send your comments and engineering stories to rwee@imaspub.com. ■

PEOPLE NEWS

Engineers Finish Burk Facility Management Training

Sixteen broadcast engineers completed Burk Technology's factory training at its headquarters in Littleton, Mass. Training on facility management software, such as the company's Lynx 5.1, was emphasized. Sessions were held over three days to keep class sizes small. Customers from six states, Nova Scotia and New Brunswick attended.

Shown on the first day of training, from left: Jody O'Leary, Astral Media Atlantic, New Brunswick; Art Neveu, WTEN(TV), Albany; Vic Deveau, Astral Media Atlantic, Nova Scotia; John Lee, WGN(TV), Chicago; Eric Fitch, WAAF(FM)/Entercom, Boston; Joe Soucise, WZLX(FM)/CBS Radio, Boston; and Don Albanese, WODS(FM)/CBS Radio, Boston.

Among the other attendees were Steve Callahan and Radio World Engineering Extra Technical Editor Michael LeClair, both of WBUR Group, Boston; Steve Tuzeneu, WNEB(AM) and WVNE(AM), Worcester, Mass.; and Steve Rieker, Radio Training Network, Sarasota, Fla.

Lynx 5.1 works with the GSC3000 and VRC2500 facility control systems to provide PC-based management and automatic control for unattended operation. Features include virtual channels, which allow new meter or status indicators based on the composite values of other channels; and custom view editor tools that integrate text files, execute Windows commands or compare meter values against a user-determined reference value.

The next training sessions are scheduled for October. Contact *bonnie@burk.com* to reserve a spot.

For more information, visit www.burk.com.

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Volume

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The level of noise is the result of the cumulative effect of all active and passive electronic elements that generate thermal noise and all sources of quantization noise imminent to the digital equipment.

One could regard headroom as a "reserve" or "safe space" where the signal never suffers distortion.

High-quality amplifiers have signal output as high as 26 dB above 0 dB without incurring distortion, and thus have 26 dB of headroom. Typical analog magnetic tape recorders have 3 percent distortion at only 8 dB above 0 dB, whereas the amplifiers have only 0.4 percent distortion at this level.

When the signal is within the headroom range — between clipping level and 0 dB level — its actual value is practically the upper margin of the achieved dynamic ratio.

Maximum headroom achieved in analog mixing consoles is 24 dB. Headroom in high-end analog tape recorders is 12 dB, in digital tape recorders 20 dB, in FM radio 6 dB, for vinyl LP records 6 dB, for CDs 20 dB and for videotape 6 dB.

The differences in meter readings are depicted in Fig. 2. The first scale on the left is a reference for dBu meter readings, Scale 1 is a standard for in-home audio, Scale 2 is a standard for digital recording equipment and Scale 3 is known as the "+4 dBu" standard for analog recording equipment.

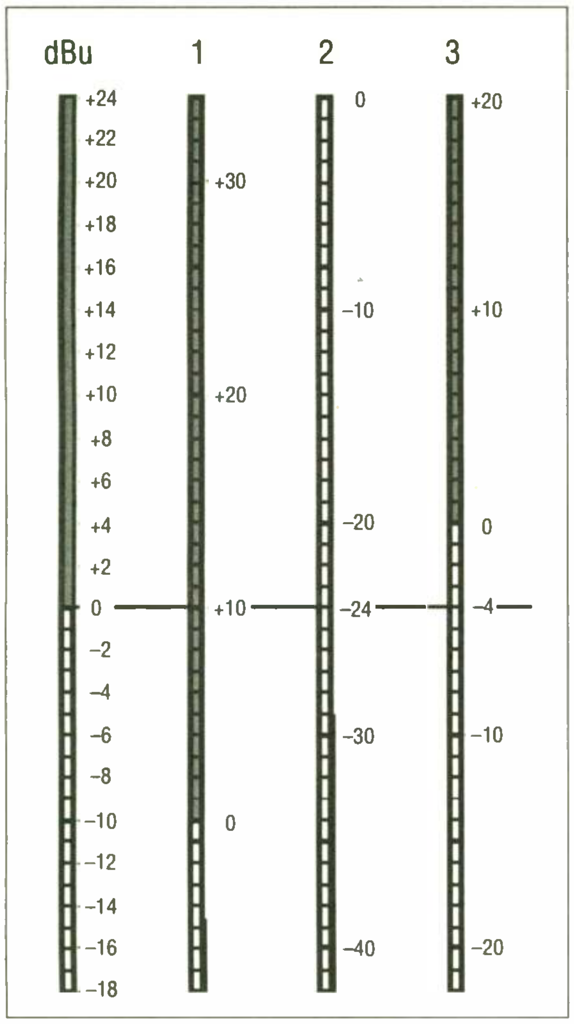

Fig. 2: The Differences in Audio Level Meter Readings

In digital audio systems, a 0 dB FS (full scale) level means the maximum permitted amplitude of the signal before clipping, as shown in Scale 2 in Fig. 2.

Therefore a board operator in a radio station, to the greatest extent possible, must anticipate the amount of headroom, depending on the statistical values of expected program material.

Operators of digital equipment have to define the reference working level, which might be regarded as a logical equivalent to the 0 dB level for analog audio equipment.

Operators of digital equipment have to define the reference working level, which might be regarded as a logical equivalent to the 0 dB level for analog audio equipment.

It is important never to exceed the level of 0 dB FS, because it would result in excessive and drastically unpleasant distortions. In this area, analog equipment, where there is always a certain amount of acceptable over-reading above the reference level of 0 dB and where distortion has a continuous, but relatively slow rise, digital equipment is much less forgiving.

COMPLETELY DIFFERENT

This is the main reason why signal level metering for digital audio is completely different from the usual practice with analog audio.

It is usual to adapt the headroom of some 20 dB, but there is no general rule, since it depends on the circumstances and the type of program. When the operator sets headroom to 20 dB FS, this practically means that the signal level pointer has to be at the level 20 dB below the 0 dB (full scale) level, in other words –20 dB FS.

For some types of sound material, especially with smaller dynamic ratio, it is recommended to work with 18, 16 or even 14 dB headroom only, which means –18 dB FS, –16 dB FS and –14 dB FS, respectively.

Contact Blazo Guzina via e-mail at blazo_guzina@yahoo.com; or visit www.geocities.com/blazo_guzina. ■

CDs

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high-quality programming that is also different from conventional programs is difficult and expensive. The cost of technical upgrading is trivial compared to the ongoing cost of compelling program production.

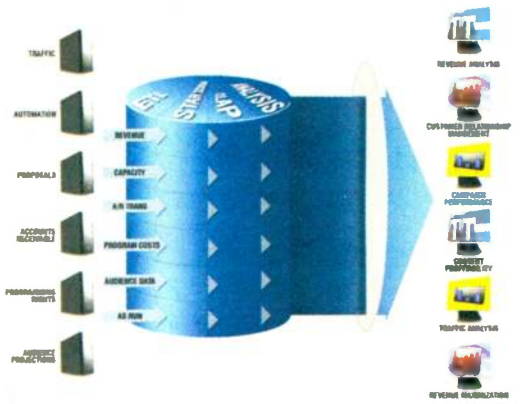
In other words, HD Radio cannot be evaluated as a technology; it is an enabler. And the question is, what will it enable? To listeners, one radio box is equivalent to another radio box, except for differences in what comes out of the loudspeakers. HD is interesting if, and only if, those differences are relevant to listeners.

Dr. Barry Blesser is director of engineering for 25-Seven Systems. Contact him with comments and topic suggestions at barryblesser@25-seven.com. ■

MARKETPLACE

BIAnalytix Provides Sales With Campaign Updates

BIAnalytix Business Intelligence from Decentrix is a data analysis tool aimed at media companies. It can be used by various outlets including broadcast TV and radio.



The supplier says the sales department of a major U.S. broadcast group plans to upgrade its data warehouse to this new system, which provides real-time analysis for linear and Web-based programming and ad content business models.

"With the BIAnalytix data warehouse installed centrally, precise and reconciled data from all stations will be available daily to sales management, who will be able to monitor the ongoing effectiveness of the multi-station agency campaigns analyzed by ISCI material codes and dayparts," the company stated.

BIAnalytix uses the scalable SQL Server 2005, with analysis provided by portal-based Excel pivot technologies. Media-oriented templates are provided.

Decentrix, based in Denver, also offers software for companies to build and manage e-commerce sites, disseminate and control Web content and analyze advertiser and site visitor behavior. It has various tools for monitoring and measuring cross-platform ad campaigns.

For information call the company in Colorado at (303) 899-4000 or visit www.bianalytix.com.

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by Barry Blesser

CDs Prove Secondary Features Matter

Size and Longevity, Not Audio Quality, Drove Success; So What Will Attract Consumers to HD Radio?

Interpreting current events from a historic perspective is the prerogative of someone who has lived for more than six decades. There are not many advantages to being old, but that is one of the obvious ones.

We have all read extensive discussions about the future of radio broadcasting, and the belief that the HD format will be a revolutionary technology that may (could, should) revitalize an industry that has been around for almost a century. Though HD Radio technology clearly is modern, there are analogies that may shed some light on its future. If nothing else, history may help us find the relevant questions.

QUALITY CONTROL

As one of the fathers of digital audio in the 1970s, my opinion often was sought on how this fledgling technology would evolve. Around 1980, I predicted that the CD would never be a commercial success. And my family reminds me of this prediction whenever they think I need a dose of humility. However, the story is actually subtler and more complex than this simple quotation.

To place my flawed prediction into its historic context, let us rewind the clock to the early 1960s when the dominant means for distributing recorded music was the long-playing 33-rpm vinyl, which had been designed in the 1930s.

At RCA, a compressed air line at the periphery fed some 50 asynchronous stamping machines. Periodically during the day, the machines would all trigger at the same time, but the compressed air supply was grossly inadequate, having been designed only for an average pressing load. Some 50 bad disks resulted. Moreover, record manufacturers were continually downgrading the quality of their vinyl stock in order to save money. There was no quality control on recordings produced.

The technical manager at RCA in charge of pressings, well aware of the simplicity behind improving quality, made a proposal to a senior VP to upgrade the pressing facilities with a corresponding increase in manufacturing cost of about $0.25 per disk. At that time, RCA had a policy of replacing any defective disk that was returned, no questions asked, and with that replacement came three free additional disks.

The VP responded to the technical manager with a challenge: collect the statistics on returned disks as evidence that customers cared about quality recordings. To make a long story short, there were no returned disks. And RCA did not upgrade their pressing plants.

> **Around 1980, I predicted that the CD would never be a commercial success. My family reminds me of this whenever they think I need a dose of humility.**

In 1980, discussions about the value of the digital CD format focused exclusively on audio quality: high signal-to-noise ratio, no dust or scratches, no degradation with use, perfect concert hall transparency, flat frequency response, insignificant distortion, high channel separation and so on. Engineers were in love with the dramatic improvement in quality, and they were sure that the public would also appreciate it. Yet, the experience at RCA argued that consumers were indifferent to quality. Who was right?

By looking at the history of the CD, we know that it was a dramatic success and that the vinyl record became a museum curiosity. Philips and Sony were justified in their investment of $600 million (1980 dollars) to bring the CD to market. That investment paid handsomely.

But a market analysis of consumer attitudes showed that this new CD technology was valued for its longevity, reduced size, ability to be played in automobiles and portable devices, and eventually for the possibility of burning CDs at home. With the advent of compatible computers, users now had a vast array of inexpensive and sophisticated software tools to manipulate audio tracks.

Although the CD was a big hit, audio quality was not at the top of the list of important features. The secondary features made it a commercial success.

Now at the beginning of the 21st century, we can again look at the issue of audio quality by observing two branches of digital audio: the Super Audio CD (SACD) and compressed audio (MPEG).

These two branches move in opposite directions. The SACD offers even higher audio quality than the conventional CD, but otherwise it has the same secondary properties as an ordinary CD. Conversely, in an effort to reduce the size of audio files, to expand the amount of music that can fit on a CD, and to reduce download time, compression technology is widely used even though it degrades audio quality, especially with high compression ratios.

We know which branch dominates the market. The SACD is all but dead, and most audio tracks are very compressed. Apparently, audio file size and download time are far more important than quality. Furthermore, most listeners who use headphones on cheap CD or MP3 players are experiencing yet additional forms of audio degradation. The flat frequency response of the CD is far from flat when listening in this way.

CONSUMERS DETERMINE VALUE

Now back to the original question about interpreting HD Radio from an historical context. What features would encourage listeners to adopt this new technology? Is it analogous to the SACD vs. conventional CD, a change that only improved audio quality? Or, is it analogous to the old vinyl disk vs. CD, a change that offered a large number of secondary features, (eventually) valued by listeners? These are the relevant questions for HD Radio.

When we are making a decision to invest in a new technology, marketing research does not always formulate the correct questions. I was not smart enough to recognize that the CD's secondary features were important and that they would have a big impact on the lifestyle of listeners.

Consumers must perceive value on their terms, not from the perspective of the designer or manufacturer, in order to justify the effort and expense of upgrading. The CD forced consumers to upgrade their playback systems and their record libraries, and similarly, the HD format requires listeners to upgrade their radios.

HD Radio is advertised as having many advantages to listeners: reception with almost CD quality, absence of static and crackles, transmission of additional information and addition of multiple channels. But it also reduces reception range under adverse conditions. Which of these features qualifies as having the potential to change listeners' lifestyle, and which are a repeat of the argument that listeners want quality audio?

I have an answer to this question, but we also know from my experience in 1980 that my track record for making accurate predictions leaves something to be desired. Nevertheless, here is my opinion. Increasing the number of audio programs available would have value if the additional channels contained programs that were not otherwise available, and if listeners have a strong desire to listen to those additional programs.

Simply having a larger quantity of the same kind of programming does not have high value. If we believe my reasoning, then the success of HD depends on what the broadcasters do with their additional channels. As with the CD, secondary features drive the market, not technical elegance. Unfortunately, producing

SEE CDS, PAGE 37

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